NASA-CR-203137

International Space Station *EXPRESS* Pallet

Ground Demonstration Baseline Design Review

July 20, 1995

Section I
Introduction

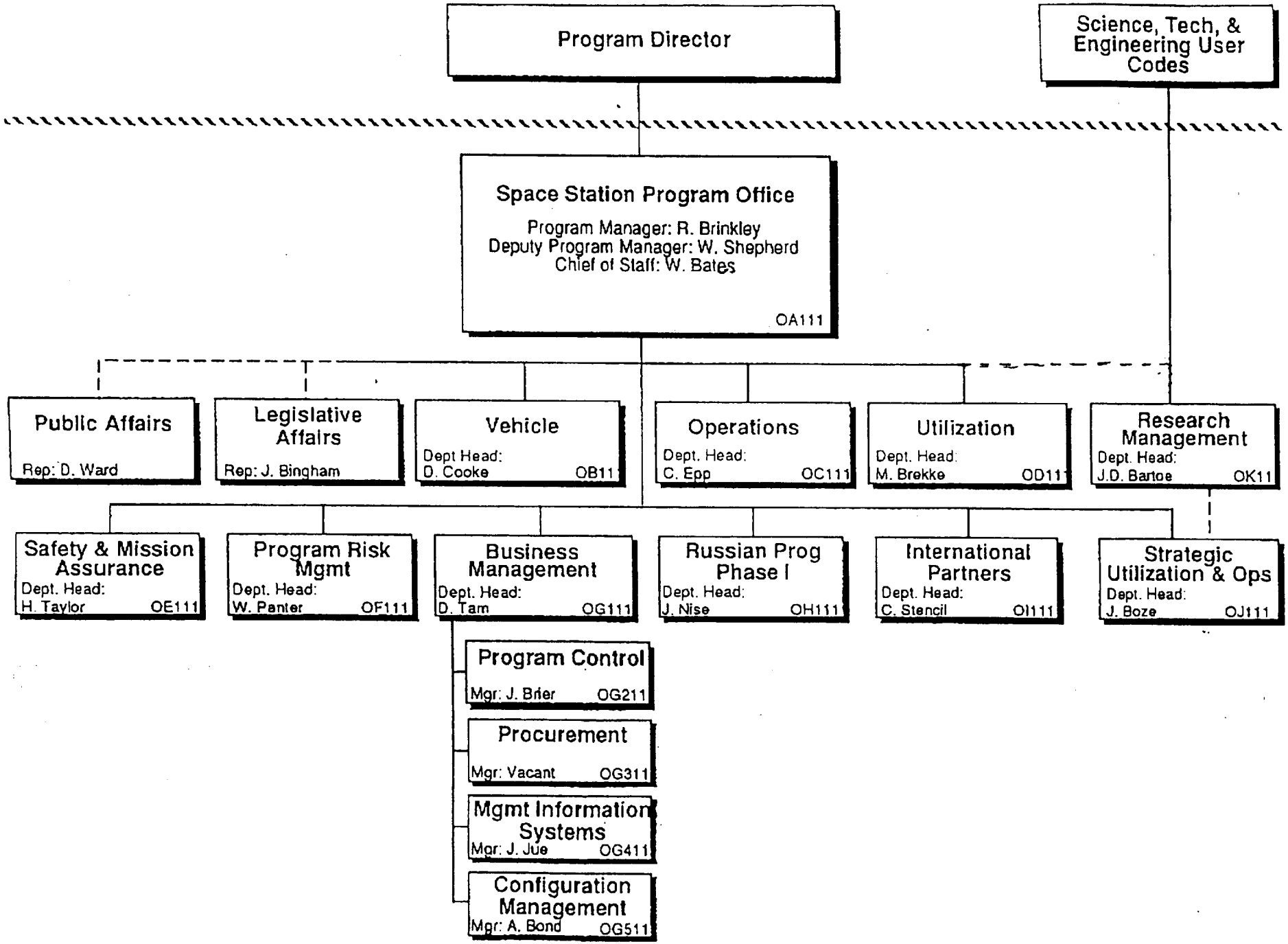
EXPRESS Pallet
Ground Demonstration Baseline Design Review

Lowell Primm

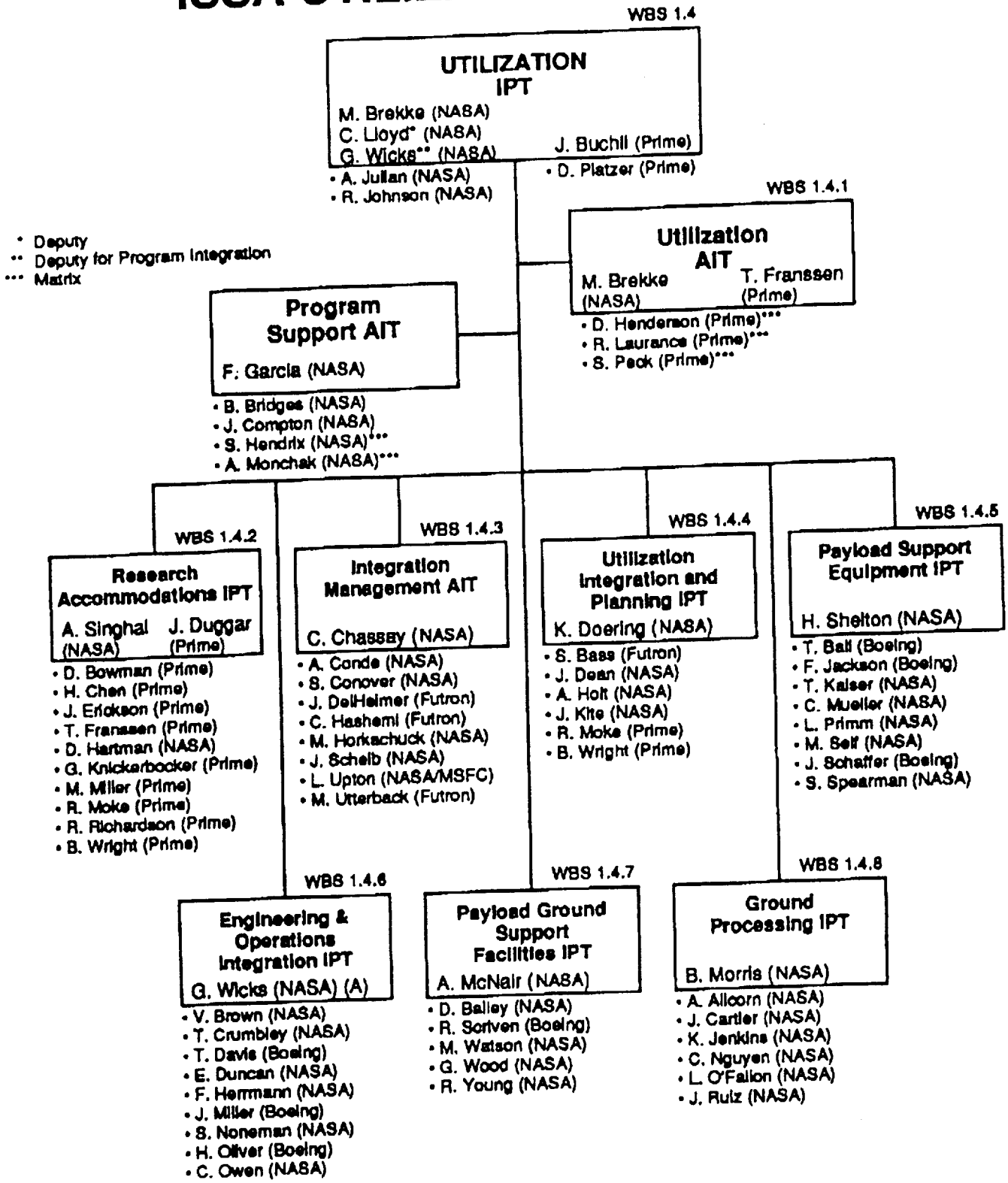
Agenda

EXPRESS Pallet
Ground Demonstration Baseline Design Review
July 20, 1995

	Presentation	Presenter	Time
I.	Introduction	Lowell Primm	8:30 to 8:45
II.	Requirements	Lowell Primm	8:45 to 9:15
III.	Objectives	Jim Schaffer	9:15 to 9:45
	Break		**9:45 to 10:00**
IV.	Systems	Brad McCall	10:00 to 10:30
V.	Mechanical	Jim Charles	10:30 to 11:30
	Lunch		**11:30 to 12:30**
VI.	Electrical Power System	Brad McCall	12:30 to 12:50
VII.	Data System	Brad McCall	12:50 to 1:20
VIII.	Software	Vance Davis	1:20 to 2:00
	Break		**2:00 to 2:15**
IX.	Operations		2:15 to 2:30
X.	KSC Integration and Operations	C. Nguyen	2:30 to 3:00
XI.	Document Tree	Jim Scheib	3:00 to 3:15
XII.	Payload Candidates	Lowell Primm	3:15 to 3:30
XIII.	Thermal	Darin Boyer	3:30 to 3:45
XIV.	Ground Demo. vs Flight	Jim Schaffer	3:45 to 4:15
XV.	Summary - Recommended Actions - Next Meeting	Lowell Primm	4:15 to 4:30
XVI.	Adjourn		4:30


Program Director
Science, Tech, & Engineering User Codes
Space Station Program Office
Program Manager: R. Brinkley
Deputy Program Manager: W. Shepherd
Chief of Staff: W. Bates
OA111
Public Affairs
Rep: D. Ward
Legislative Affairs
Rep: J. Bingham
Vehicle
Dept Head:
D. Cooke
OB11
Operations
Dept. Head:
C. Epp
OC111
Utilization
Dept. Head:
M. Brekke
OD111
Research Management
Dept. Head:
J.D. Bartoe
OK11
Safety & Mission Assurance
Dept. Head:
H. Taylor
OE111
Program Risk Mgmt
Dept. Head:
W. Penter
OF111
Business Management
Dept. Head:
D. Tam
OG111
Russian Prog Phase I
Dept. Head:
J. Nise
OH111
International Partners
Dept. Head:
C. Stencil
OI111
Strategic Utilization & Ops
Dept. Head:
J. Boze
OJ111
Program Control
Mgr: J. Brier
OG211
Procurement
Mgr: Vacant
OG311
Mgmt Information Systems
Mgr: J. Jue
OG411
Configuration Management
Mgr: A. Bond
OG511

ISSA UTILIZATION AITs/IPTs ☆



M. Brekke Date

J. Buchli Date

☆To be revised with O&U consolidation

05/20/95
12:55 p.m.

EXPRESS PALLET
AIT MEMBERS

Lead - Lowell E. Primm

CUSTOMERS

Code U/E. Reeves/M. Sistilli

Code Y/V. Hall

Code S/M. Kicza

Code Y/D. Stone/D. Brewer

LaRC/D. Avery, E. Mauldin

MSFC/J. Fountain, J. Owens

ESA/A. McGrath

CSA/J. Foster

ISSA

HQ/OD/M. Brekke/J. Scheib

Payload Science and Utilization

Boeing/T. Recio

PALLET CHIEF ENGINEER

MSFC/EJ44/M. Self

P/L GROUND PROCESSING

KSC/CM-INT/C. Nguyen

PAYLOAD ANALYTICAL ENGR.

MSFC/JA63/V. Brown

PALLET IPT

MSFC/JA64/L. Primm

Boeing/J. Schaffer

RMO

OK/J. Bartoe/J. Bates/G. McCollum

EXPRESS Pallet IPT

Leads:
- *L. Primm 544-9145*
- J. Schaffer 961-4942

Core Team Members:

- *Payload Integration Manager: Jim Scheib (713) 244-8394*
- *Chief Engineer: M. Self 544-9597*
- Systems Engineering: Brad McCall 961-1263
- *Customer Support: C. McLemore 544-2314*
- Software Design: K. Bushue 961-4937
- Mechanical Design: J. Charles 961-1266
- Thermal Design: Darin Boyer
- Test: TBA
- **Packaging Design: TBA**
- Operations and Training: B. Trach 961-4717
- Systems Analysis: TBA
- **Tech Aid: TBA**

Non-Core Team Members:

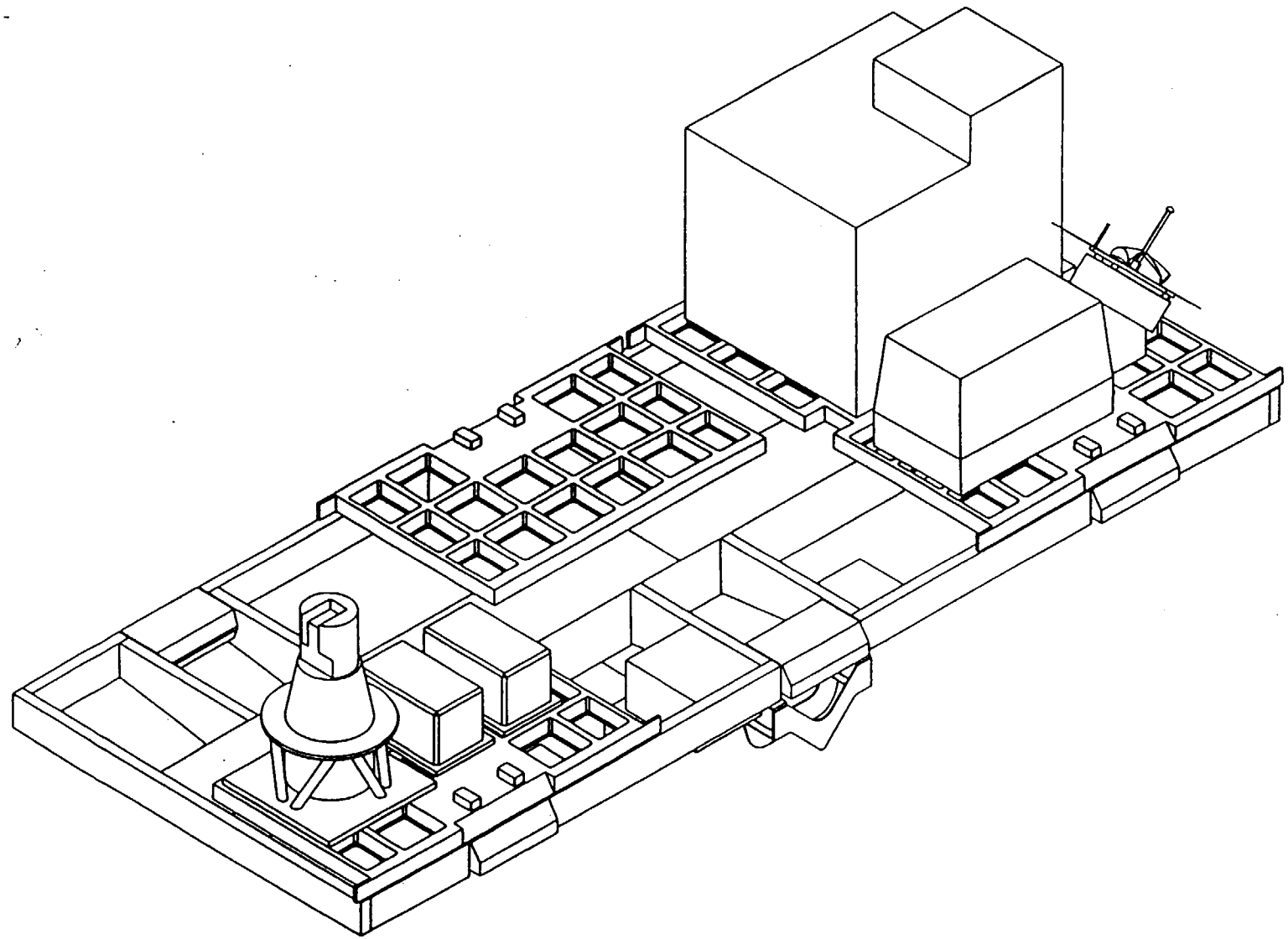
- S& MA: D. Day 961-0037
- Tech Aid: Lisa Wilson 961-4636
- Secretary: Lisa Wilson 961-4636
- *Verification: Donna Holland 961-0140*
- *S& E reps.:*
 Materials: Tamera Landers
 Electrical Power: TBA
 Data: TBA
 Software: Louis Simeone 544-3779
 Structures: TBA
 Thermal: Jon Holladay 544-7250
 Systems: Sonya Sisk 544-2463
 Space Systems: TBA
 Man Systems: TBA
- EMI/EMC: R. Werp 461-5773
- **Electrical Design: TBA**
- **Mechanical Design: TBA**
- Stress: TBA
- PAI: D. Dolson 961-4841*
- Mfg.: Marc Swenson 961-4802
- Mfg. Mockup: D. Anderson 961-4965
- Material: D. Romig 461-5865
- PP&C: R. Passero 961-4597
- Contracts: D. Lucas 461-2220

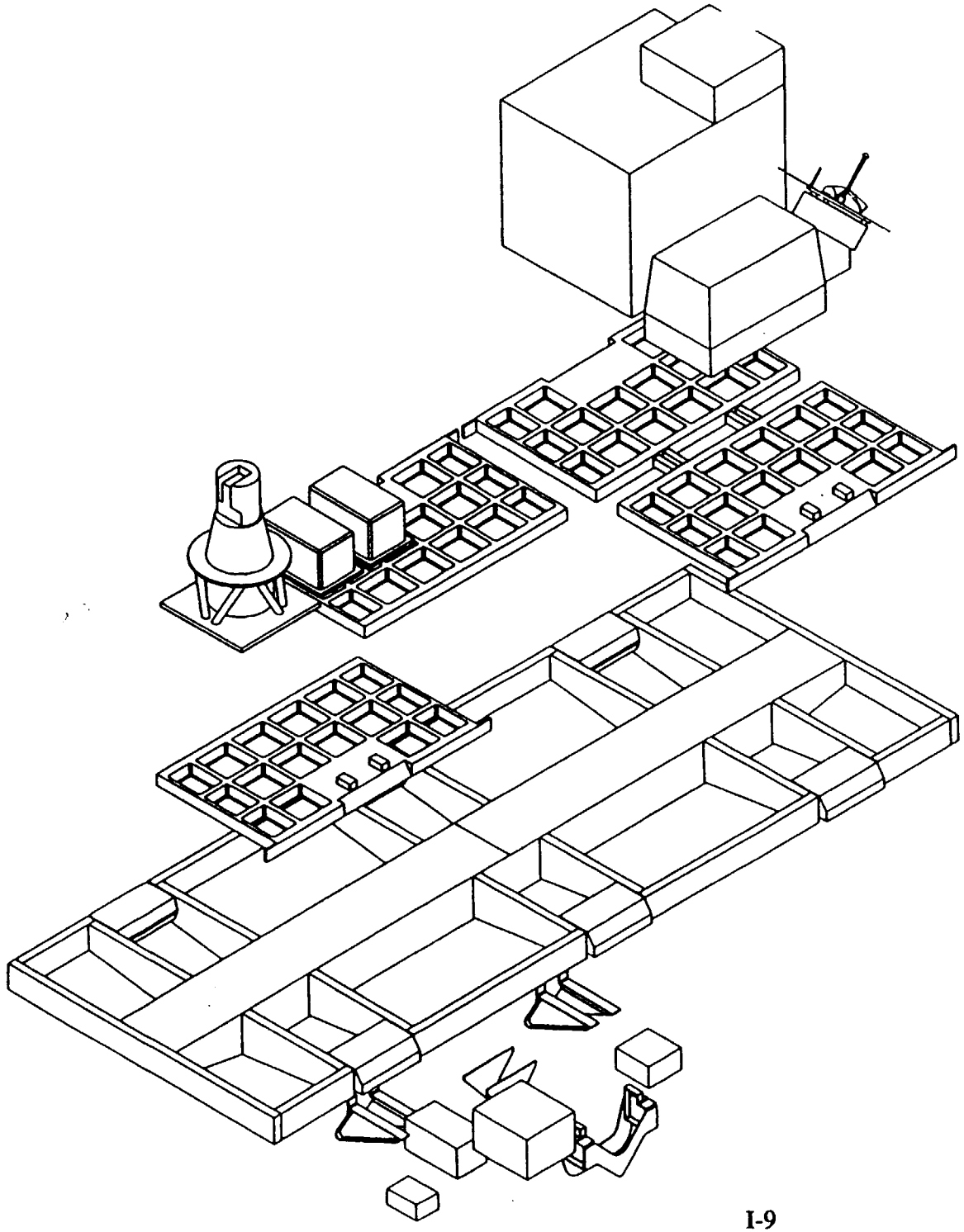
* Acting

EXPRESS Pallet Overview

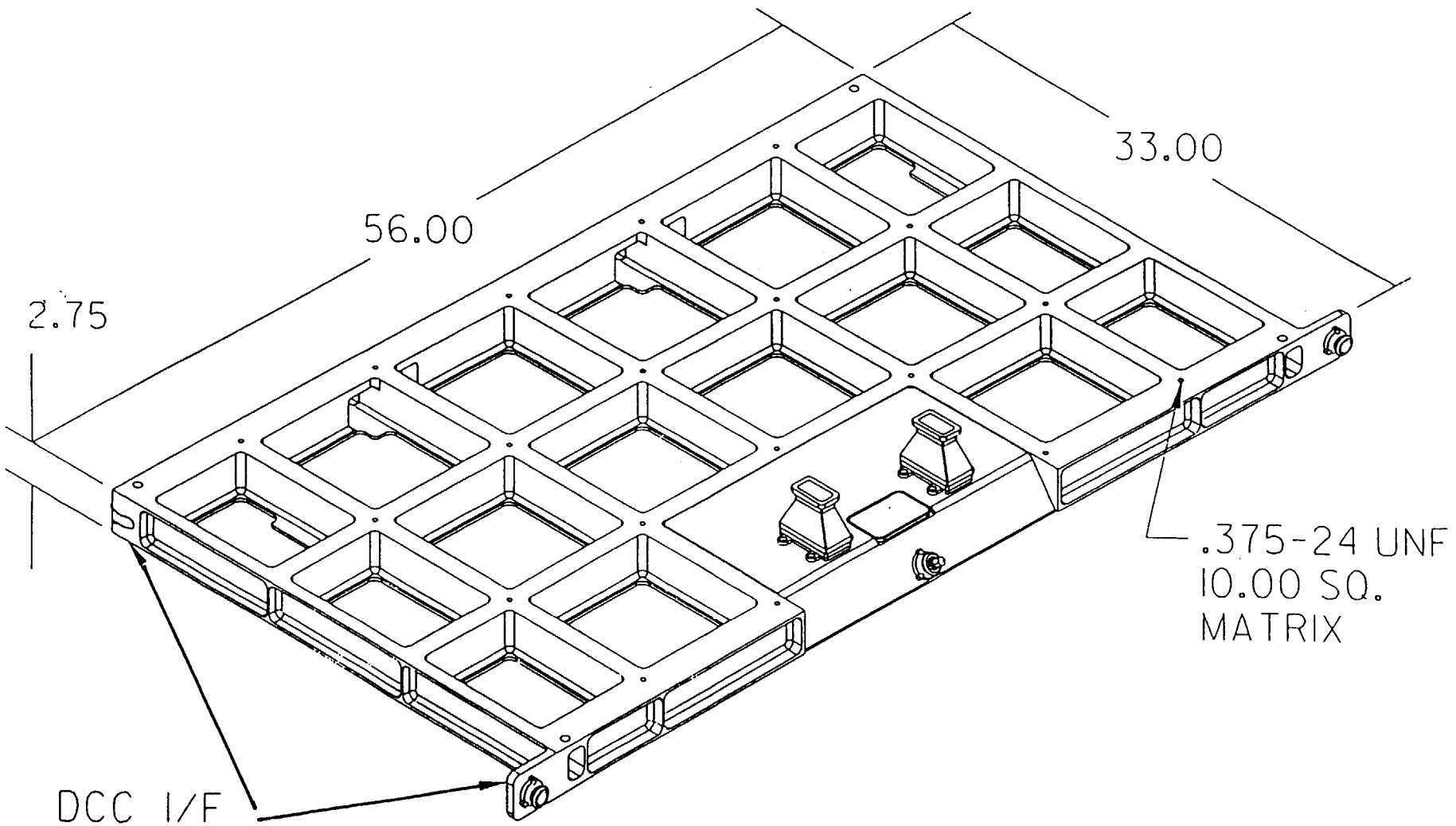
- EXPRESS Pallet program consists of: Pallets, Adapters, subsystems
- *Pallet*: Structural, functional interface with ISSA
 - Attaches to ISSA truss, remains on-orbit
 - Carries up to 6 Adapters
- *Adapters*: Customer interface (mechanical, electrical)
 - Payloads mounted to Adapters
 - Provides payload functional I/F with Pallet
 - Removed/installed using robotics
 - Changed-out on as-needed basis
- *Subsystems*: Pallet controller, power systems, etc.

EXPRESS Pallet

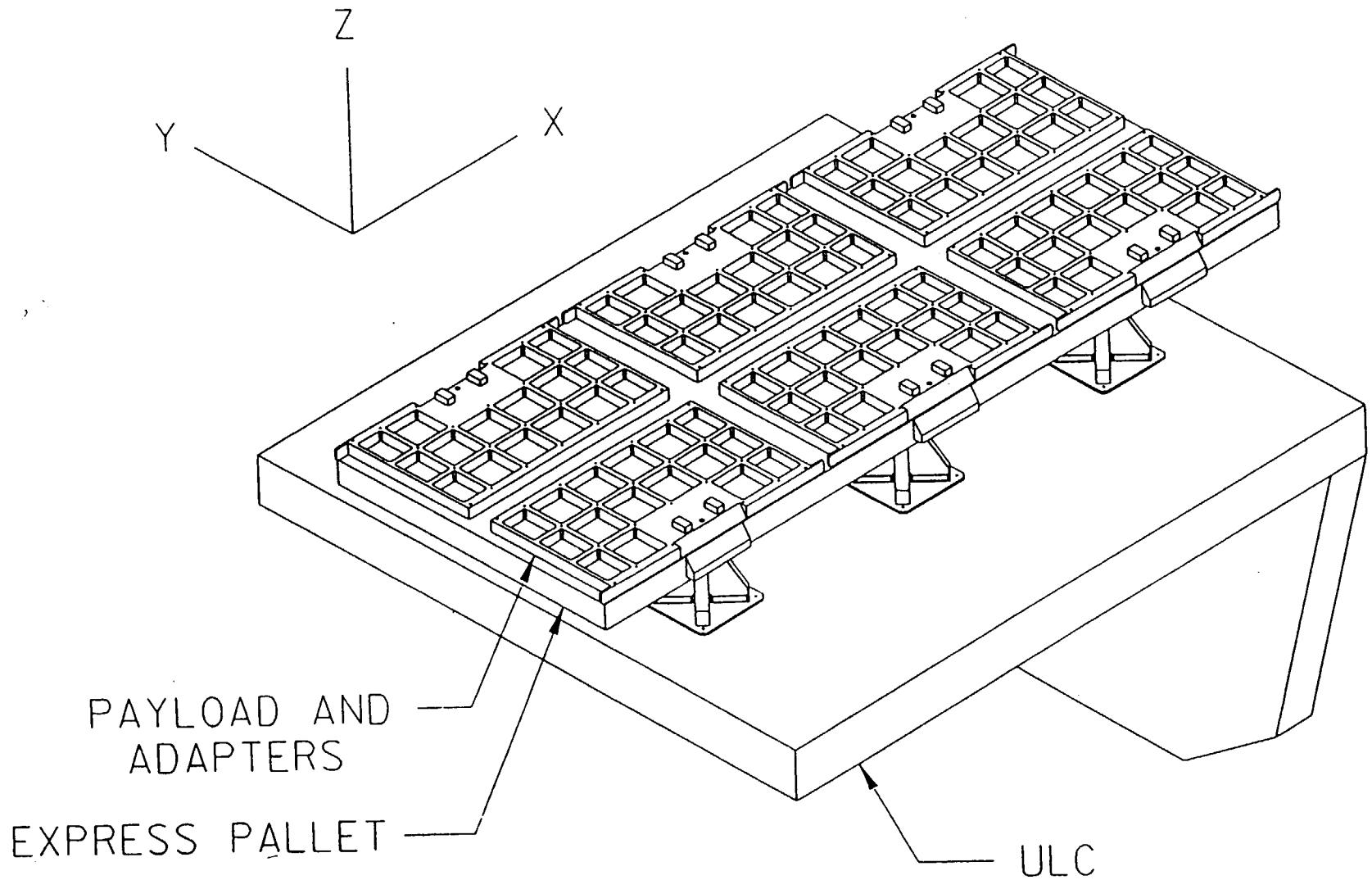




EXPRESS Pallet Adapter



EXPRESS Pallet & Unpressurized Logistics Carrier



EXPRESS Pallet Concept

- Prelaunch: (1) Payloads integrated onto Pallet adapters
 (2) Adapters mounted on Pallet
 (3) EXPRESS Pallet attached to Unpressurized Logistics Carrier (ULC)
- Launch: (1) ULC/Pallet launched on Shuttle
- On-Orbit: (1) Pallet removed from ULC
 (2) Attached to ISSA Payload Attach Structure (PAS)
- Operations: Pallet remains on-orbit for life of Station
- Payload changeout, using Adapters:
 (1) Adapters/ payloads removed from Pallet
 (2) Returned using Dry Cargo Carrier (DCC)
 (3) New payloads installed onto adapters
 (4) Adapters/payloads launched using DCC
 (5) Adapters removed from DCC and attached to Pallet

EXPRESS Pallet
Program Content

- Program consists of:
 - 4 flight Pallets
 - 20 Adapters (16 single, 4 double)
 - Avionics
 - EVR, EVA systems (contingency)
 - Trainer, Simulator, NBS trainer
- Deliver 1st Pallet for UF-4
 - Support earlier flight, if required
- *Customer accommodations*:
 - Power: 3.0 kw @ 120 Vdc; 500-900 W @ 28Vdc
 - Footprint: 56" x 33"footprint (single adapter)
 - Weight capability: 6000lbs (Pallet); 500-1000lbs (Adapter)
 - Command, control, telemetry
 - MS 1553, High Rate Data Link, RS422, RAU, discrete, analog
 - Viewing: RAM, Wake, Nadir, Zenith, Starboard, Port

EXPRESS Pallet Status

- Pallet included in ISSA baseline program- funded thru FY 2004
- Entered ground demonstration phase of program
 - Conducted Preliminary Requirements Review
 - Engineering effort nearing completion
 - Purchasing long lead hardware
- Ground Demonstration Baseline Design Review scheduled July 20
- Demo Hardware: Utilized as Engineering Development Article
- CRITICAL NEED: *Demonstration payloads & requirements*
- NEW INITIATIVE: *Flight demonstration with SPAS payload*
 - Risk Mitigation for flight H/W
 - Provides new Logistics Carrier capability
 - Currently unfunded





Section II
Requirements

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Lowell Primm

EXPRESS Pallet
Ground Demonstration Requirements

- Provide one functional Pallet
- Provide multiple, functional Adapters
- Design to Flight Footprint: Same as flight configuration
 - Pallet: 16 ft x 6 ft
 - Adapters: 63" x 33"
- Volume: Approximate flight configuration
- Provide power capability:
 - 120 Vdc to subsystems
 - 120 Vdc & 28 Vdc to payloads
- Functional Data Interface:
 - MS 1553
 - RS 422/485
 - Discrete
 - Analog

EXPRESS Pallet
Ground Demonstration Requirements (cont)

- Provide Command and Control of Multiple Payloads
 - Pallet controller
 - Simultaneous C&C
- Simulate ground stations
- Verify (limited) EVR capability: Adapter "Swap"
 - Connector Mechanisms
 - Grappling Hardware (microconicals, etc.)
- Verify (limited) EVA compatibility
 - Connector Mechanisms
 - Simulated EVA H/W
- Verify processes and operations (where applicable)
 - On-orbit
 - Pre-launch integration

- Limited form, fit, function engineering development article





Section III
Objectives

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Jim Schaffer

Contents

- Ground Demonstration Program
 - Hardware Process
 - » KSC Level IV Integration
 - Program Documents
 - » JSC Annexes
- Operations
- Hardware
 - Fabrication
 - Assembly, Installation, Test and Checkout
 - Integration
 - Support HW
- Strengthen ISSA Attached Payload Community
- Define "Standard" *EXPRESS* Pallet Payloads
- Understand "Non-Standard" *EXPRESS* Pallet Payloads; e.g. Optional Services

- Better understand the integration process through exercising the system:
 - International Partner HW
 - Subsystems development
 - Level IV Integration
 - "Walk-Through" JSC Annex Process; e.g. IDD/ICDs

- Multiple Adapter/Payload Operation
- Adapter Change-Out
- Simulated Ground Station:
 - Command & Control
 - Data throughput
- Payload Command & Control :
 - Turn power on/off
- Subsystems Command & Control:
 - Enable/Disable *EXPRESS* Pallet Subsystems

Hardware

- Objectives -

EXPRESS Pallet Ground Demonstration Baseline Design Review

- Two Active Bay Configuration
- Include limited EVA/EVR systems Hardware
- Payload Physical Accommodations:
 - Payload to Adapter Interface Demonstration and Verification
 - Cable routing/installation
 - EVA/EVR stayout requirements
- Pallet to Adapter Physical Accommodations:
 - Connector engagement:
 - » Mating Force
 - » Alignment
 - Hard-Point Interface verification:
 - » Zip-Nut/Captive Bolt Operation
 - EVA/EVR stayout requirements
 - Mating Mechanism Verification

- "Transparent" Payload Reconfiguration:
 - Data Interfaces
 - Power Interfaces
 - Adapter to Pallet Interface Commonality
- Pallet Environment Monitoring
 - Thermal

Strengthen ISS Attached Payload Community

- Objectives -
EXPRESS Pallet Ground Demonstration Baseline Design Review

- Involve payload community with early *EXPRESS* Pallet HW development:
 - Preliminary Requirement Reviews
 - Baseline Design Reviews
 - Demonstration Program
- Support Science Community:
 - SSUAS
 - NRC
- Participate in ISS Activities:
 - APWG
 - ISS Reference Guide
- Work Directly with the payload developers:
 - SAGE III
 - MEF
 - ATMOS
 - HH



Define "Standard" *EXPRESS* Pallet Payloads

- Objectives -

EXPRESS Pallet Ground Demonstration Baseline Design Review



- Standardize the *EXPRESS* Pallet envelope:
 - Mass
 - c.g.
 - Volume
 - Electrical Power
 - Data services
 - Robotics
 - etc.



"Non-Standard" *EXPRESS* Pallet Payloads

- Objectives -

EXPRESS Pallet Ground Demonstration Baseline Design Review

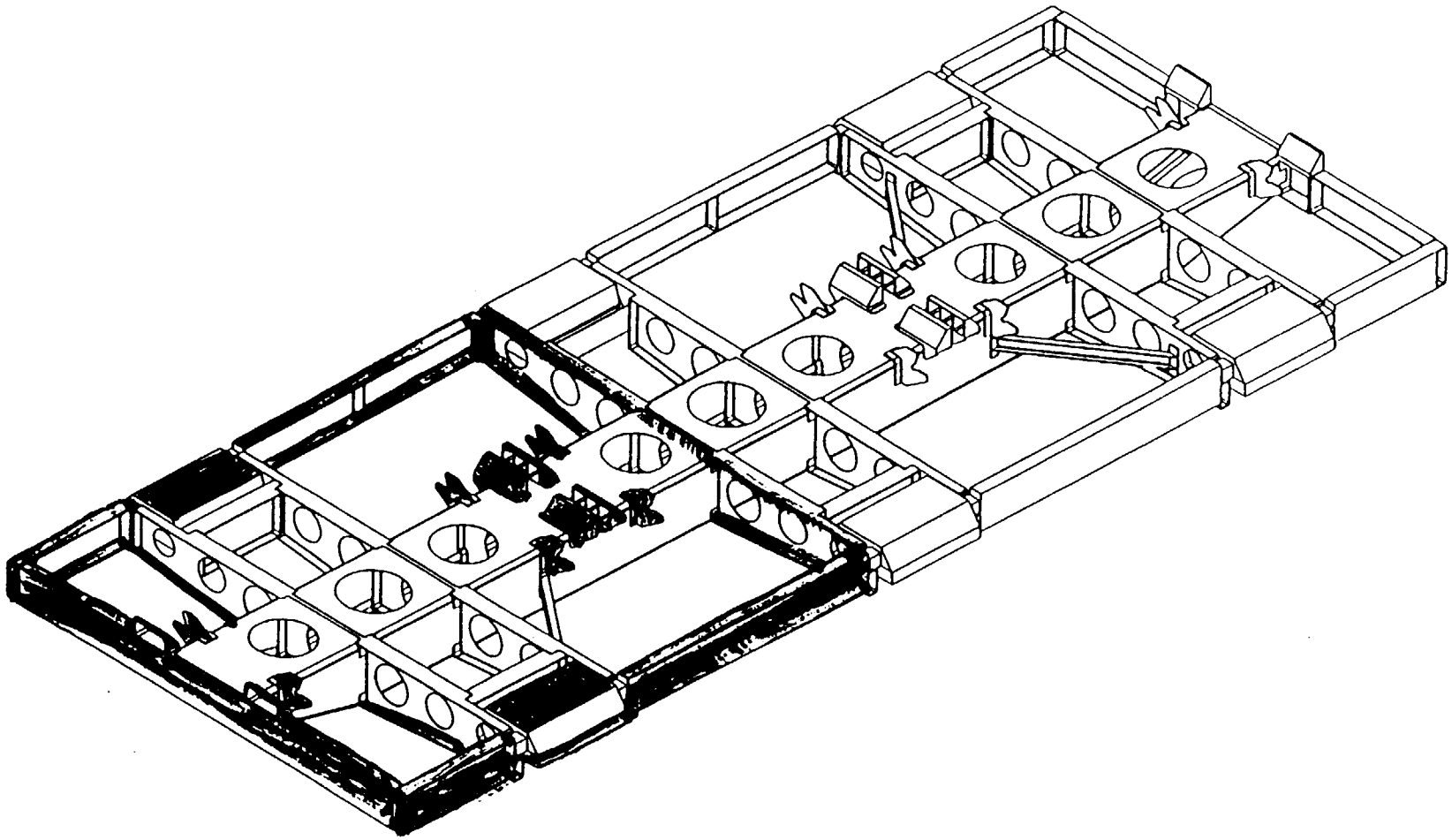


- Define "non-standard" kits:
 - Active Thermal Conditioning
 - Survival Batteries
 - etc.

Ground Demonstration HW Configuration

- Objectives -

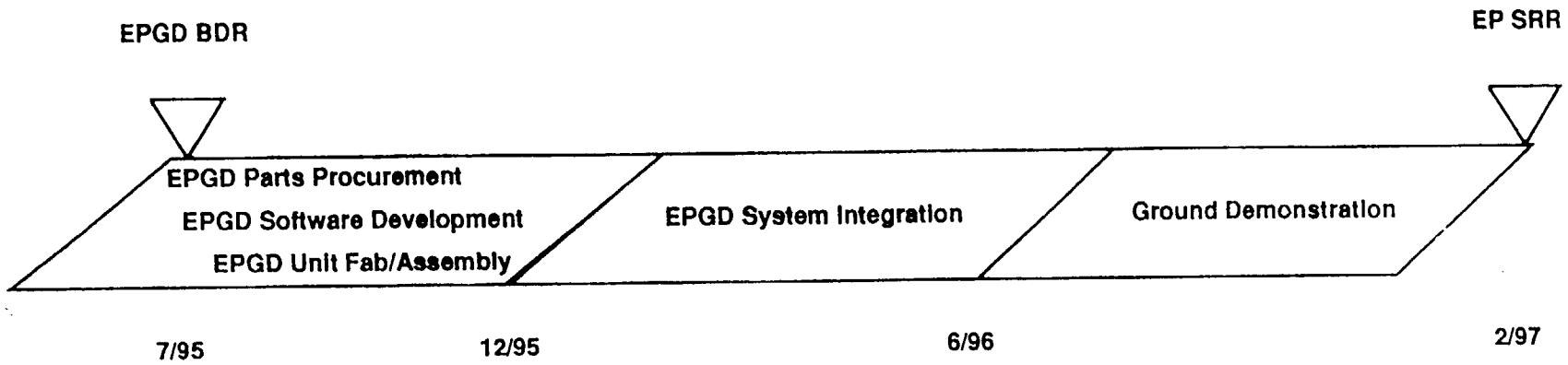
EXPRESS Pallet Ground Demonstration Baseline Design Review



Major Milestones

- Objectives -

EXPRESS Pallet Ground Demonstration Baseline Design Review



Major Accomplishments to Date

- EXPRESS Pallet Ground Demo (EPGD) component procurement in progress
- EPGD software development in progress
- EPGD Pallet and Adapter piecepart drawings delivered to Development Shop
- EPGD cabling drawings delivered to Development Shop
- EPGD SRS Draft completed
- EPGD B1 Draft completed



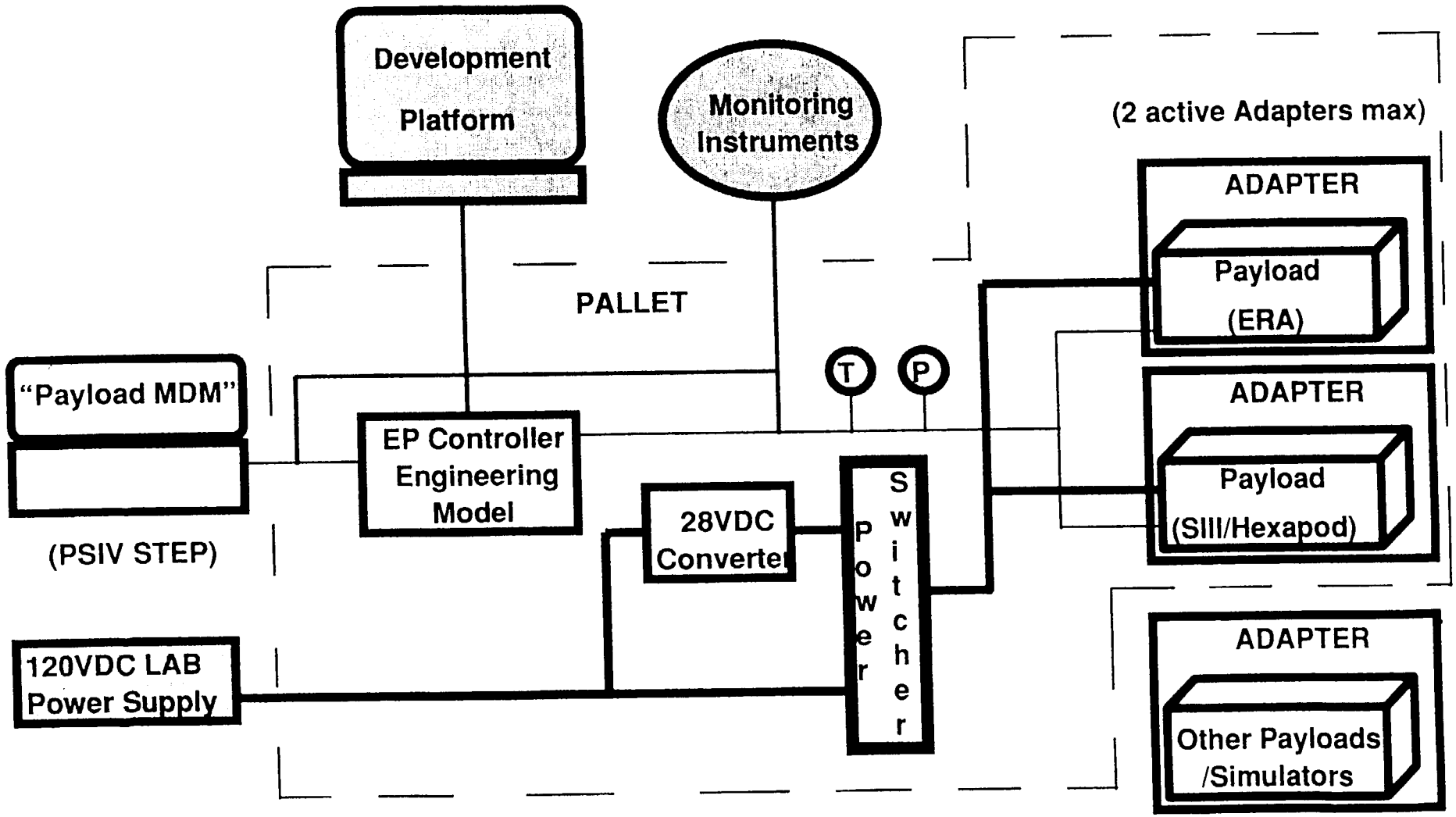


Section IV
Systems

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Brad McCall

EXPRESS Pallet Ground Demonstration System Configuration



NASA/Boeing

EXPRESS Pallet Ground Demonstration System Functions

- Simulate Ground/PEP Commands/ Status Gathering
- Demonstrate Ancillary Data Transfer to Payload
- Demonstrate Payload timeline (duty cycle-power) Control
- Design and functionally integrate Software and EP Hardware Components
- Verify Payload Interface Compatibility with EP Components
 - * Data
 - * Power
 - * Mechanical -- universal adapter mounting surface provided
- Support Multiple Payload Operation
- Demonstrate Adapter Mating/Demating
- Determine Preliminary Cable Routing

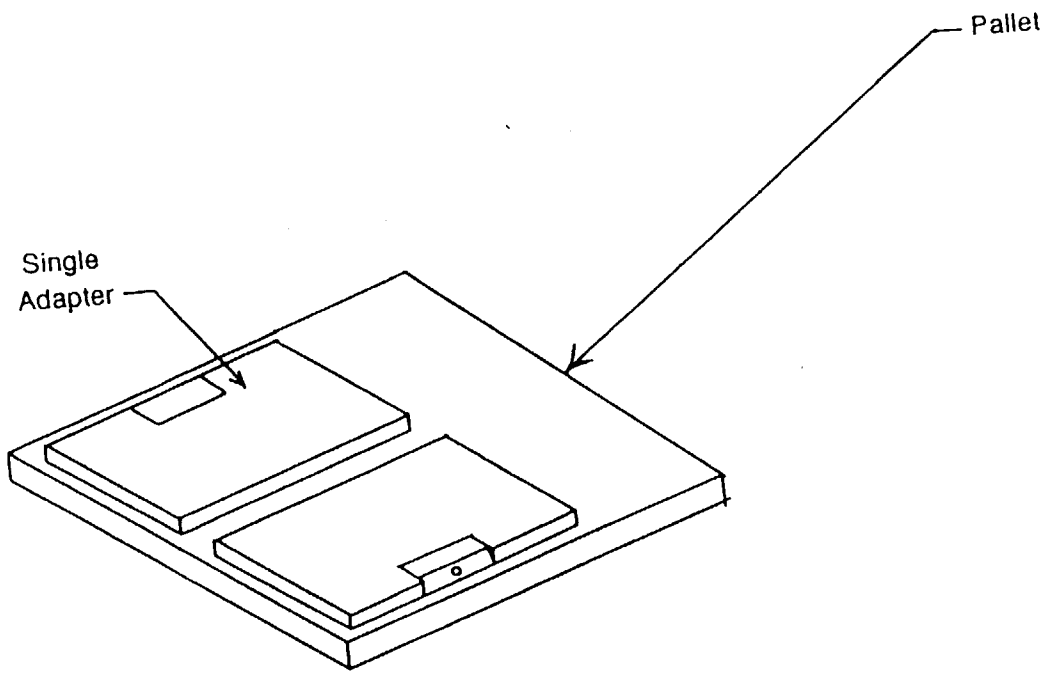
EXPRESS Pallet Ground Demonstration Core Components

ITEM	DESCRIPTION	QUANTITY	PART NUMBER
EP Controller	Data Processor/Controller	1	TBD
Power Converter	120VDC to 28 VDC Converter	1	Sunstrand Dev Unit
Power Switching Unit	120V/28V Power Switching Unit (using Sunstrand power switches)	1	683-XXXXX
Pallet	EXPRESS Pallet Structure	1	683-90060-1
Adapters	EXPRESS Pallet Adapter Structure	2	683-90020-1
Temperature Sensor	RTD Temperature Sensor	1	TBD
Pressure Sensor	Ambient Pressure Sensor	1	TBD

EXPRESS Pallet Ground Demonstration
Core Component Functions

ITEM	FUNCTION
EP Controller	Provide subsystem/payload control, monitoring and data routing
Power Converter	Provide 120VDC to 28VDC power conversion for payloads
Power Switching Unit	Provide power switching for payloads and system components
Pallet	Provide mounting structure and services for up to 2 adapters
Adapters	Provide mounting structure and services for up to 2 payloads per adapter
Temperature Sensor	Supply EP system environmental temperature data
Pressure Sensor	Supply EP system environmental pressure data

EXPRESS Pallet Ground Demonstration
Structural Components



EXPRESS Pallet Physical Diagram

NASA/Boeing

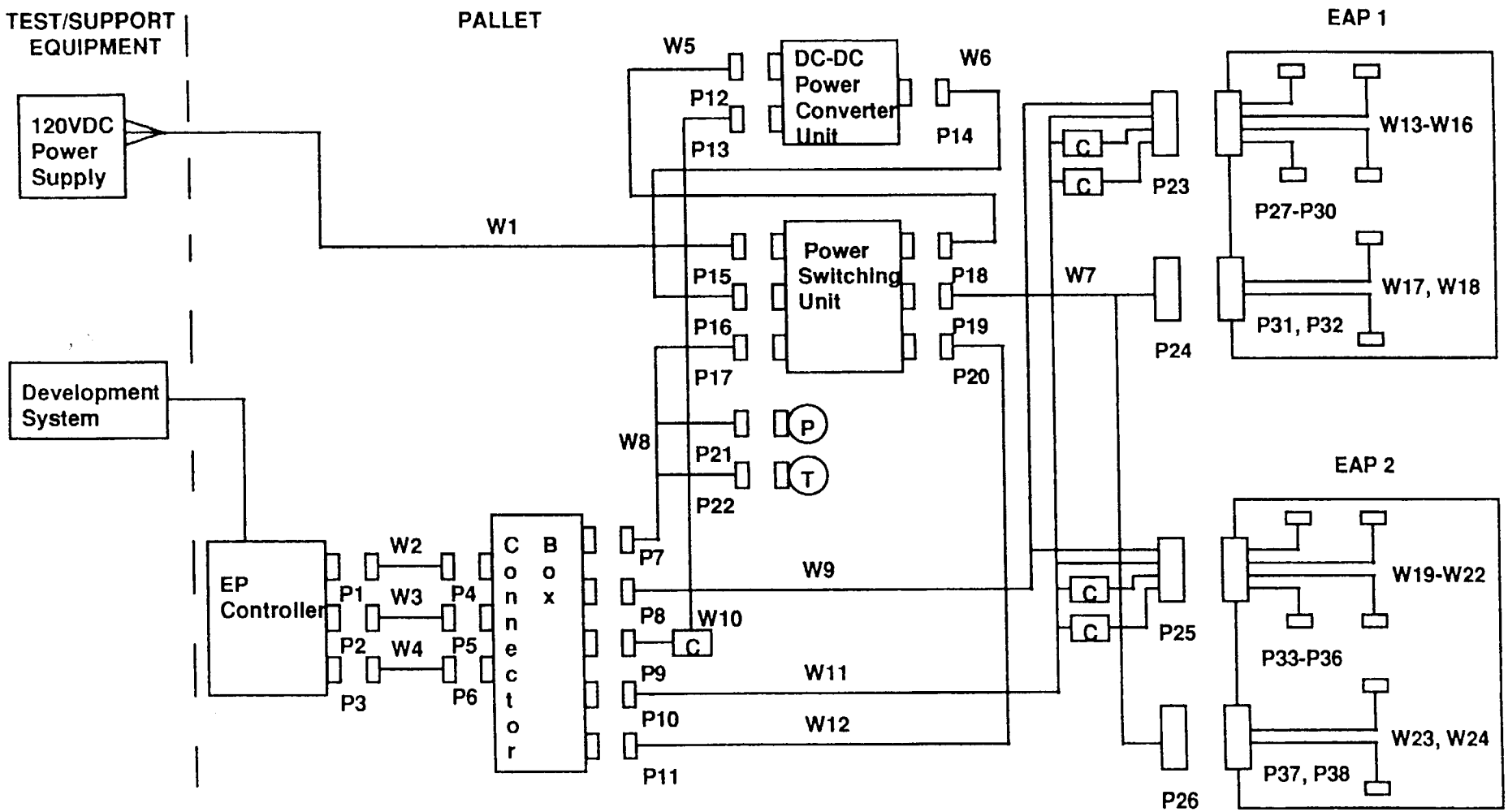
EXPRESS Pallet Ground Demonstration Support/Test Equipment

ITEM	DESCRIPTION	QUANTITY	PART NUMBER
386 Development System	Software Development System w/ In Circuit Emulator	1	Tek8301
Bus Analyzer	MIL-STD-1553B Bus Analyzer	2	Loral SBA100
Bus Analyzer	RS-422/485 Bus Analyzer (e.g. Protocol Analyzer)	1	HP4954A
O-scope	Dual Trace O-scope	1	Tektronix 7842
Computers	386/486 Personal Computer w/SBS 1553B module	1	TBD
Multimeters	Digital Multimeters	2	HP3466A Fluke 8024A
Power Supply	120VDC Power Supply	1	HP6023A
PSIV STEP	Payload Suitcase Simulator	1	683-21430-1

EXPRESS Pallet Ground Demonstration Support/Test Equipment Functions

ITEM	FUNCTION
386 Development System	Support software development/EP system debug
1553 Bus Analyzer	Monitor 1553 bus traffic (local, payload data, control busses)
422/485 Bus Analyzer	Monitor RS-422/485 bus traffic
O-scope	Monitor discrete/analog control and instrumentation signals
Computers	Support PEP/payload simulation (control, status, ancillary data)
Multimeters	Verify control signals and cable integrity
Power Supply	Supply 120VDC power to EP system
PSIV STEP	Provide simulation of PEP and Ground station

EXPRESS Pallet Ground Demonstration Cabling



EXPRESS Pallet Cable Diagram

NASA/Boeing

EXPRESS Pallet Ground Demonstration
Cabling Assemblies

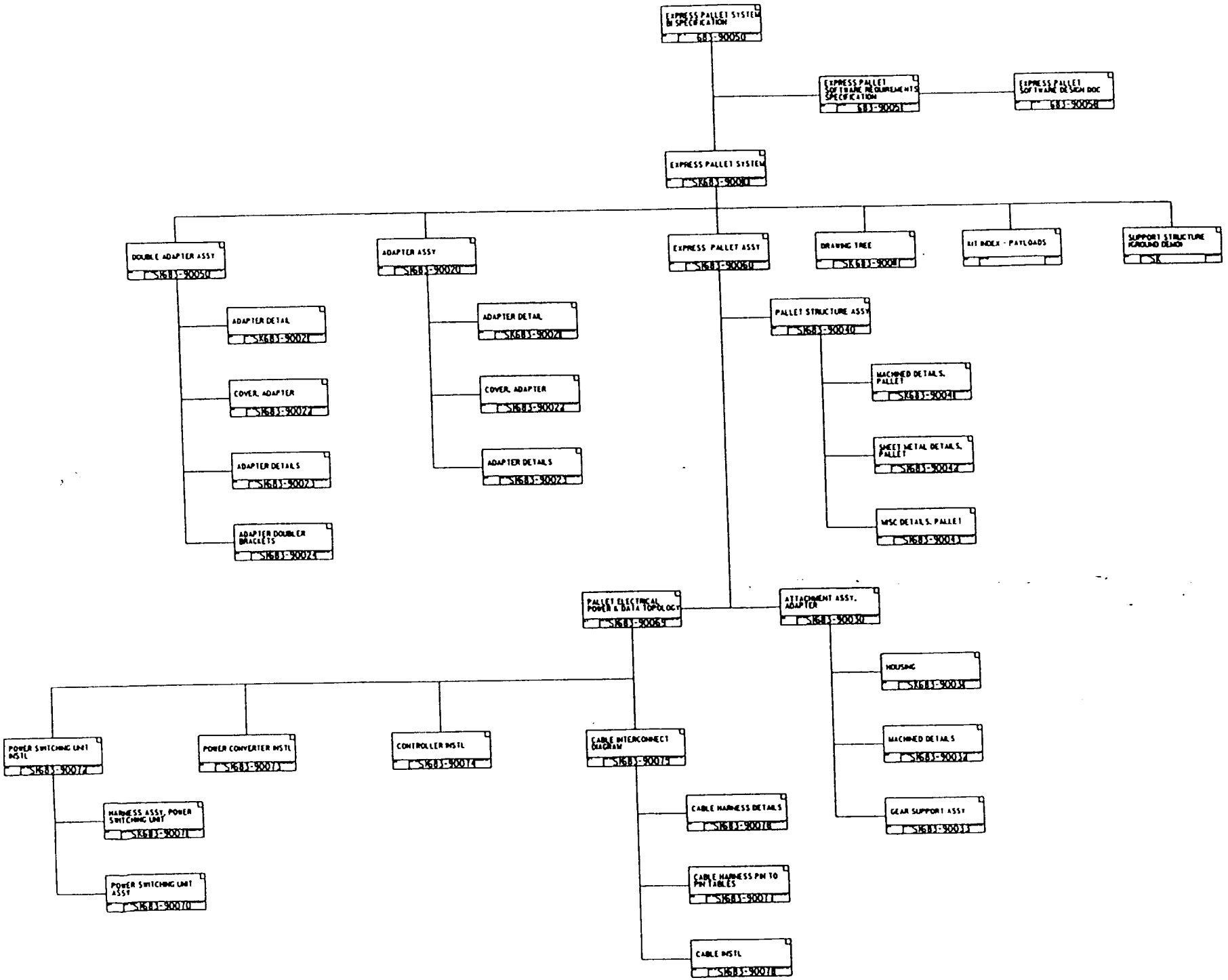
Cable Assembly	Connectors	Signals
W1	P15	120VDC power in (EO)
W2	P1, P4	LLA, HLA, DIO (MLS)
W3	P2, P5	1553, 422/485 (RF)
W4	P3, P6	120VDC power to controller
W5	P12, P18	120VDC power to converter
W6	P14, P16	28VDC power to switching unit
W7	P19, P24, P25	120VDC, 28VDC power to adapters (EAP 1&2)
W8	P7, P17, P21, P22	LLA, HLA pressure/temp inputs to controller & DO outputs to switching unit
W9	P8, P23, P26	DIO, LLA, HLA to /from adapters (EAP 1&2)
W10	P9, P13	1553 control &status to/from converter
W11	P10, P23, P26	1553, 422/485 to/from adapters (EAP 1&2)
W12	P11, P20	120 VDC power to connector box
W13	P27	Signals to/from payloads on adapter 1
W14	P28	Signals to/from payloads on adapter 1
W15	P29	Signals to/from payloads on adapter 1
W16	P30	Signals to/from payloads on adapter 1
W17	P31	120VDC, 28VDC power to payloads on adapter 1
W18	P32	120VDC, 28VDC power to payloads on adapter 1
W19	P33	Signals to/from payloads on adapter 2
W20	P34	Signals to/from payloads on adapter 2
W21	P35	Signals to/from payloads on adapter 2
W22	P36	Signals to/from payloads on adapter 2
W23	P37	120VDC, 28VDC power to payloads on adapter 2
W24	P38	120VDC, 28VDC power to payloads on adapter 2

EXPRESS Pallet Ground Demonstration Connectors

Connector	Part #	Manufacturer
P1	TBD	TBD
P2	TBD	TBD
P3	TBD	TBD
P4	KJA6T21F35PN	ITT Cannon
P5	KJA6T15F35PN	ITT Cannon
P6	KJA6T15F35PA	ITT Cannon
P7	KJA6T15F35PB	ITT Cannon
P8	KJA6T25F61PN	ITT Cannon
P9	KJA6T13F98PN	ITT Cannon
P10	KJA6T19F32PN	ITT Cannon
P11	KJA6T15F5PC	ITT Cannon
P12	KJA6T21F11PN	ITT Cannon
P13	KJA6T13F98PN	ITT Cannon
P14	KJA6T21F11PA	ITT Cannon
P15	KJA6T21F11PN	ITT Cannon
P16	KJA6T21F11PA	ITT Cannon
P17	KJA6T13F35PN	ITT Cannon
P18	KJA6T21F11PB	ITT Cannon
P19	KJA6T21F11PC	ITT Cannon
P20	KJA6T15F5PN	ITT Cannon

EXPRESS Pallet Ground Demonstration Connectors

Connector	Part #	Manufacturer
P21	TBD	TBD
P22	TBD	TBD
P23	1089-1000-004	G&H Technology
P24	1089-1000-002	G&H Technology
P25	1089-1000-004	G&H Technology
P26	1089-1000-002	G&H Technology
P27	TBD	TBD
P28	TBD	TBD
P29	TBD	TBD
P30	TBD	TBD
P31	TBD	TBD
P32	TBD	TBD
P33	TBD	TBD
P34	TBD	TBD
P35	TBD	TBD
P36	TBD	TBD
P37	TBD	TBD
P38	TBD	TBD


EXPRESS PALLET SYSTEM IRD SPECIFICATION
SK683-90050
EXPRESS PALLET SOFTWARE REQUIREMENTS SPECIFICATION
SK683-90051
EXPRESS PALLET SOFTWARE DESIGN DOC
SK683-90052
EXPRESS PALLET SYSTEM
SK683-90001
DOUBLE ADAPTER ASSY
SK683-90050
ADAPTER ASSY
SK683-90020
EXPRESS PALLET ASSY
SK683-90060
DRAWING TREE
SK683-90001
KIT INDEX - PAYLOADS
SUPPORT STRUCTURE /GROUND DEMOS
SK
ADAPTER DETAIL
SK683-90021
COVER, ADAPTER
SK683-90022
ADAPTER DETAILS
SK683-90023
ADAPTER DOUBLER BRACKETS
SK683-90024
ADAPTER DETAIL
SK683-90021
COVER, ADAPTER
SK683-90022
ADAPTER DETAILS
SK683-90023
PALLET STRUCTURE ASSY
SK683-90040
MACHINED DETAILS, PALLET
SK683-90041
SHEET METAL DETAILS, PALLET
SK683-90042
MISC DETAILS, PALLET
SK683-90043
PALLET ELECTRICAL POWER & DATA TOPOLOGY
SK683-90065
ATTACHMENT ASSY, ADAPTER
SK683-90030
HOUSING
SK683-90031
MACHINED DETAILS
SK683-90032
GEAR SUPPORT ASSY
SK683-90033
POWER SWITCHING UNIT INSTL
SK683-90072
POWER CONVERTER INSTL
SK683-90073
CONTROLLER INSTL
SK683-90074
CABLE INTERCONNECT DIAGRAM
SK683-90075
HARNESS ASSY, POWER SWITCHING UNIT
SK683-90071
POWER SWITCHING UNIT ASSY
SK683-90070
CABLE HARNESS DETAILS
SK683-90076
CABLE HARNESS PIN TO PIN TABLES
SK683-90077
CABLE INSTL
SK683-90078





Section V
Mechanical

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Jim Charles



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



EXPRESS PALLET SYSTEM

PAYLOAD ADAPTER

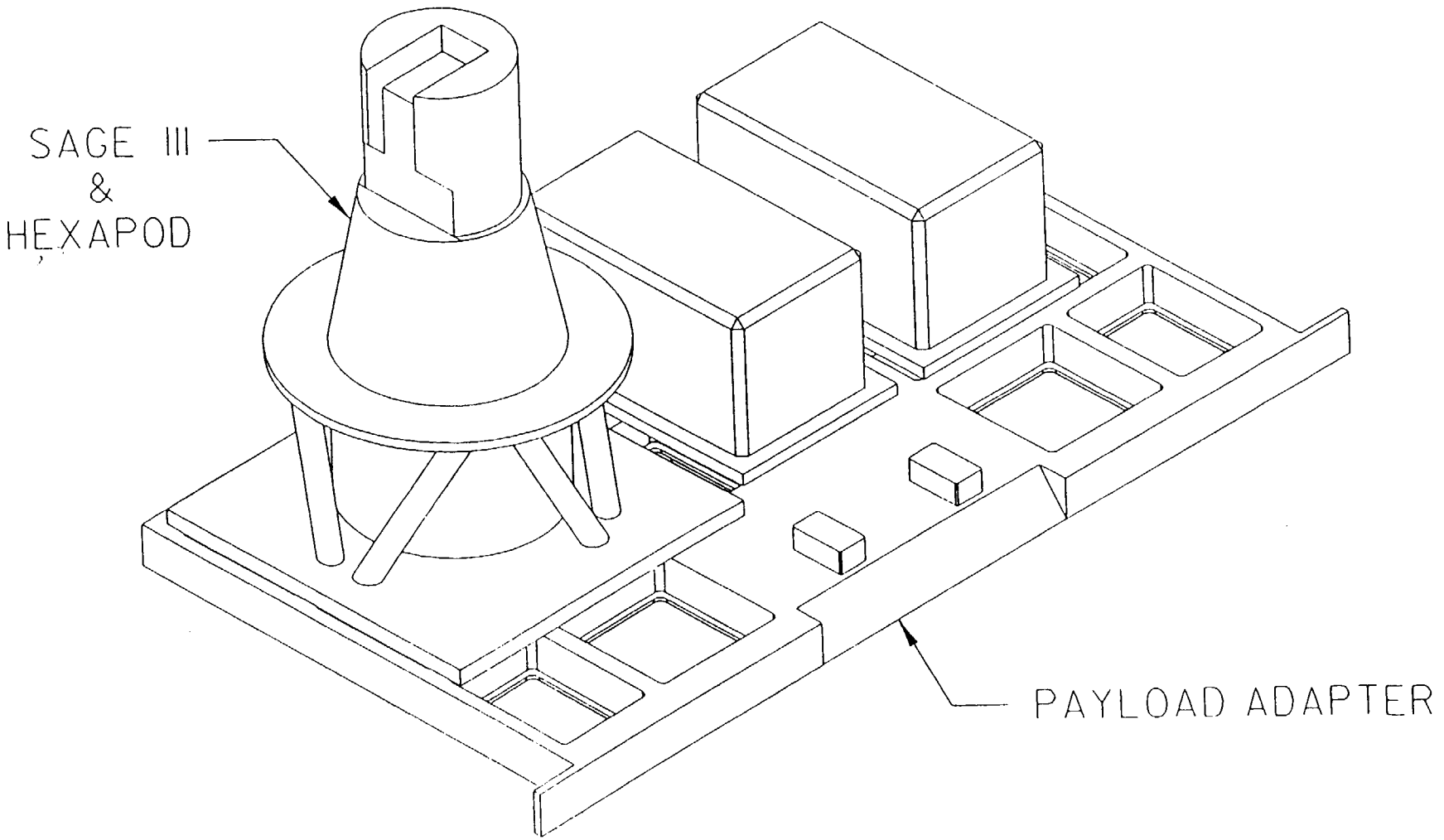
PALLET/ADAPTER INTERFACE

PALLET STRUCTURE

GROUND DEMO DESIGN PHILOSOPHY

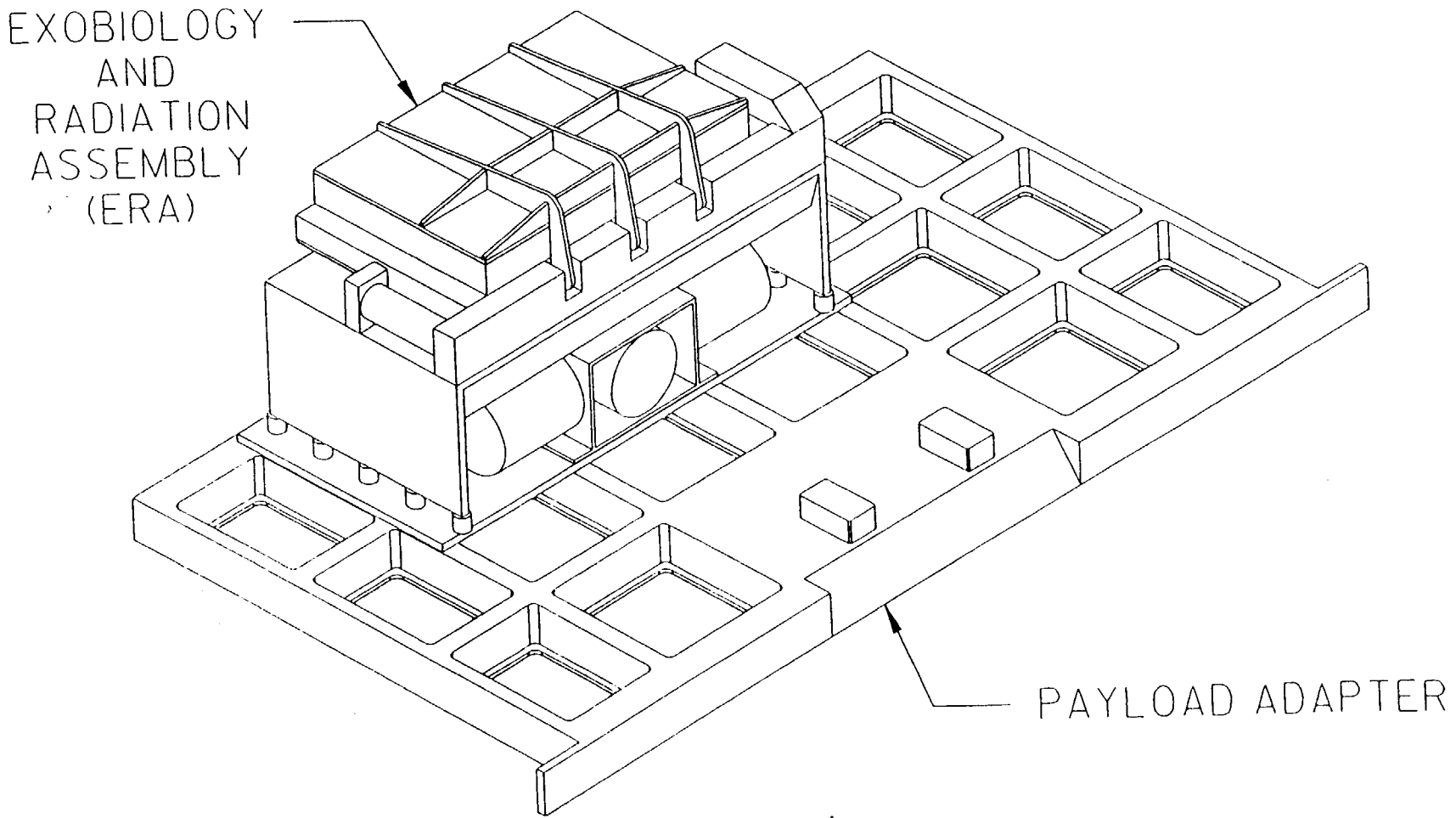
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



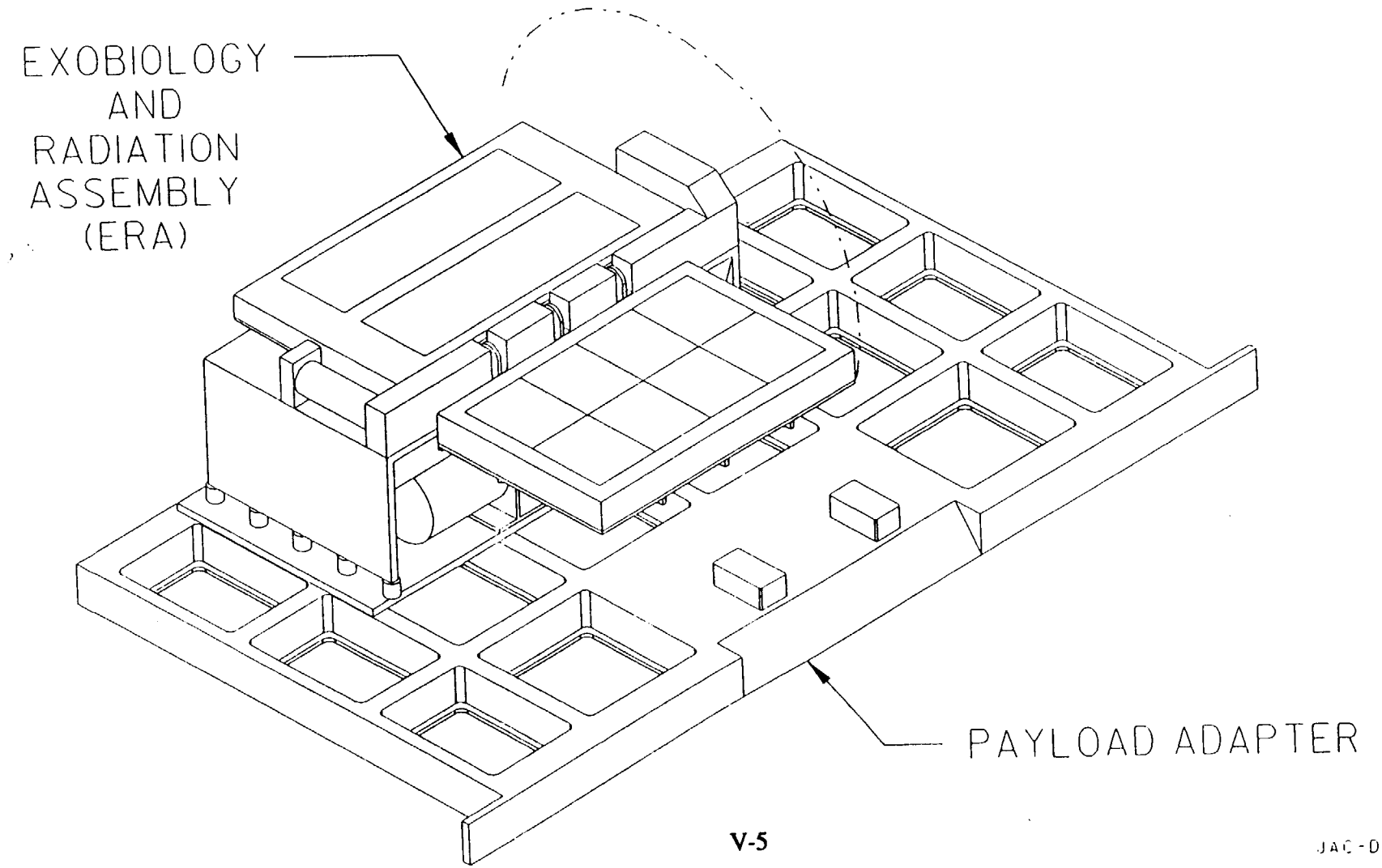
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



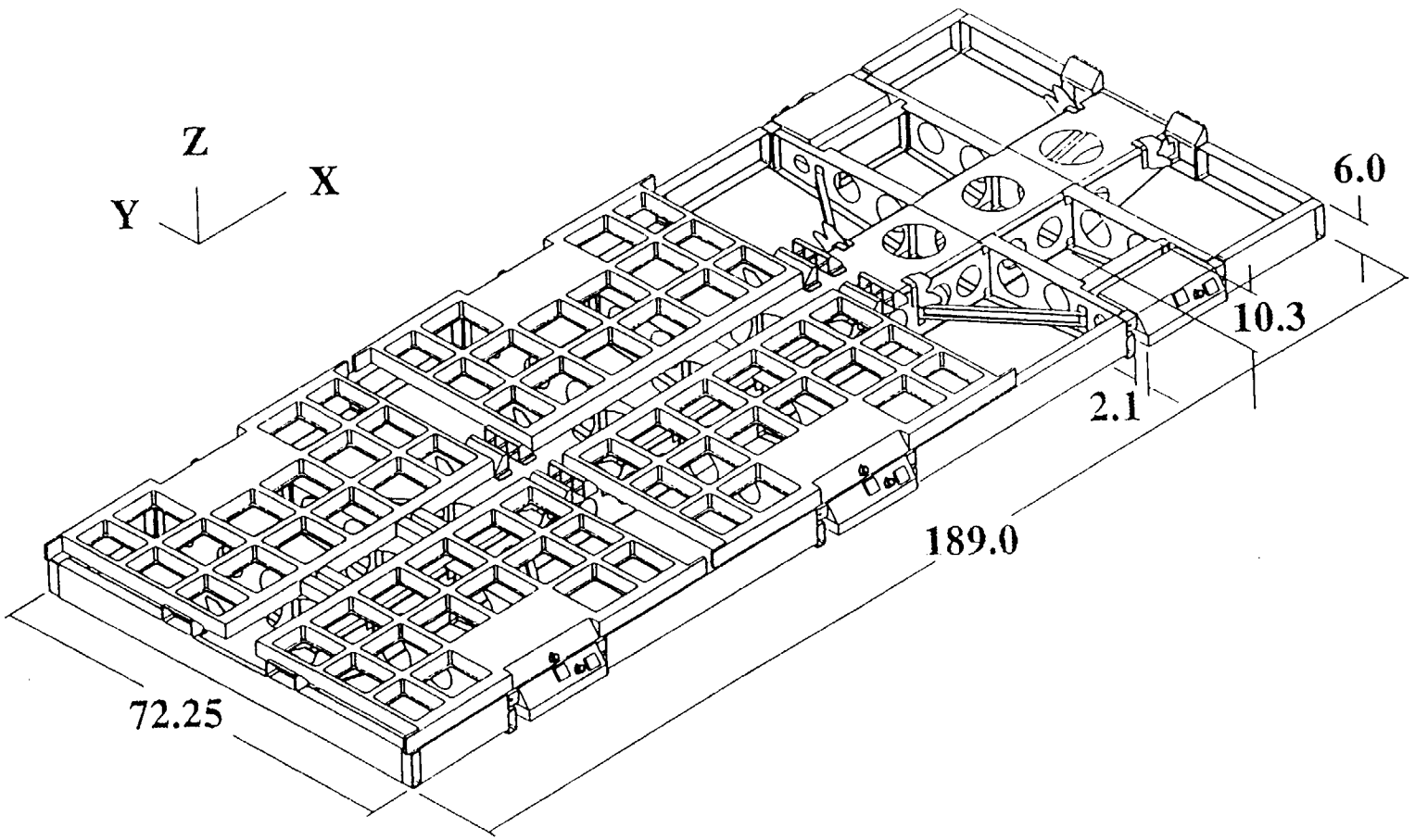
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



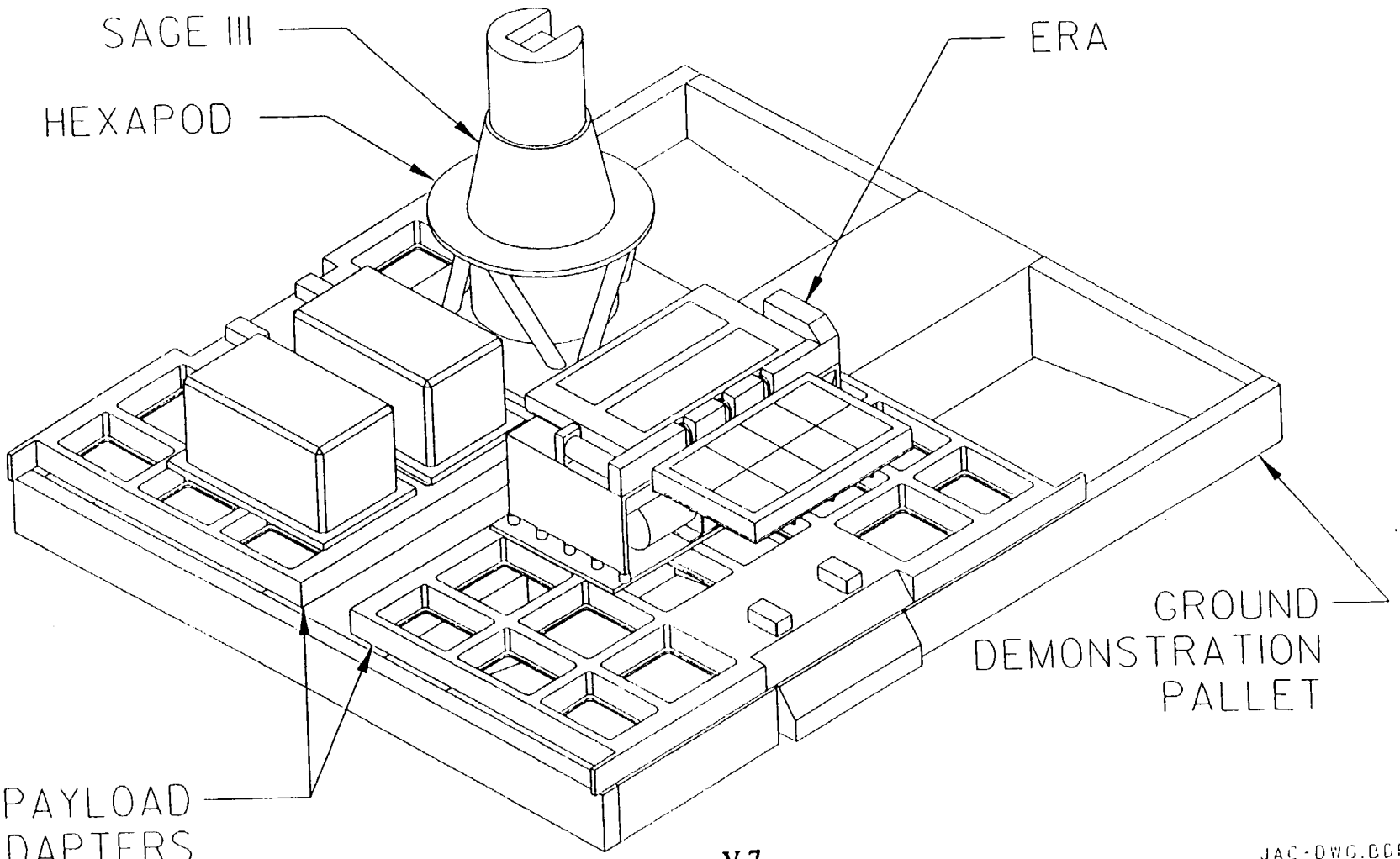
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

INTERNATIONAL SPACE STATION

PAYLOAD ADAPTER

COMPATIBLE WITH DCC

.375-24 UNF 3B THREADED HOLES - 10.00 INCH MATRIX

SEAT TRACK CONFIGURATION BETWEEN MOUNTING HOLES

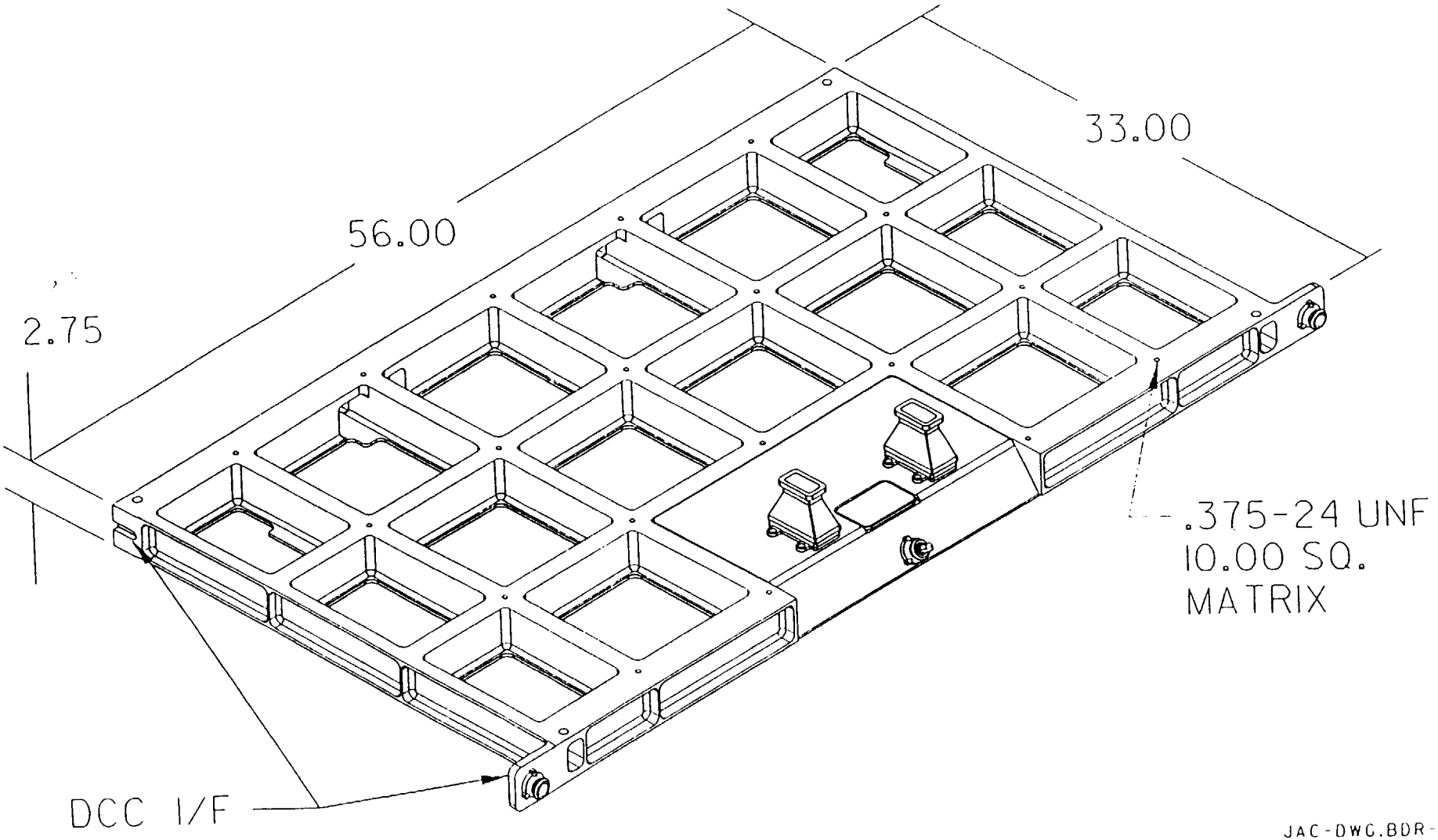
"HAT" SECTION STRUCTURE FOR MAXIMUM STIFFNESS

MACHINED FROM 7075-T7351 3.00 THICK PLATE

FINISH: ANODIZE

MECHANICAL

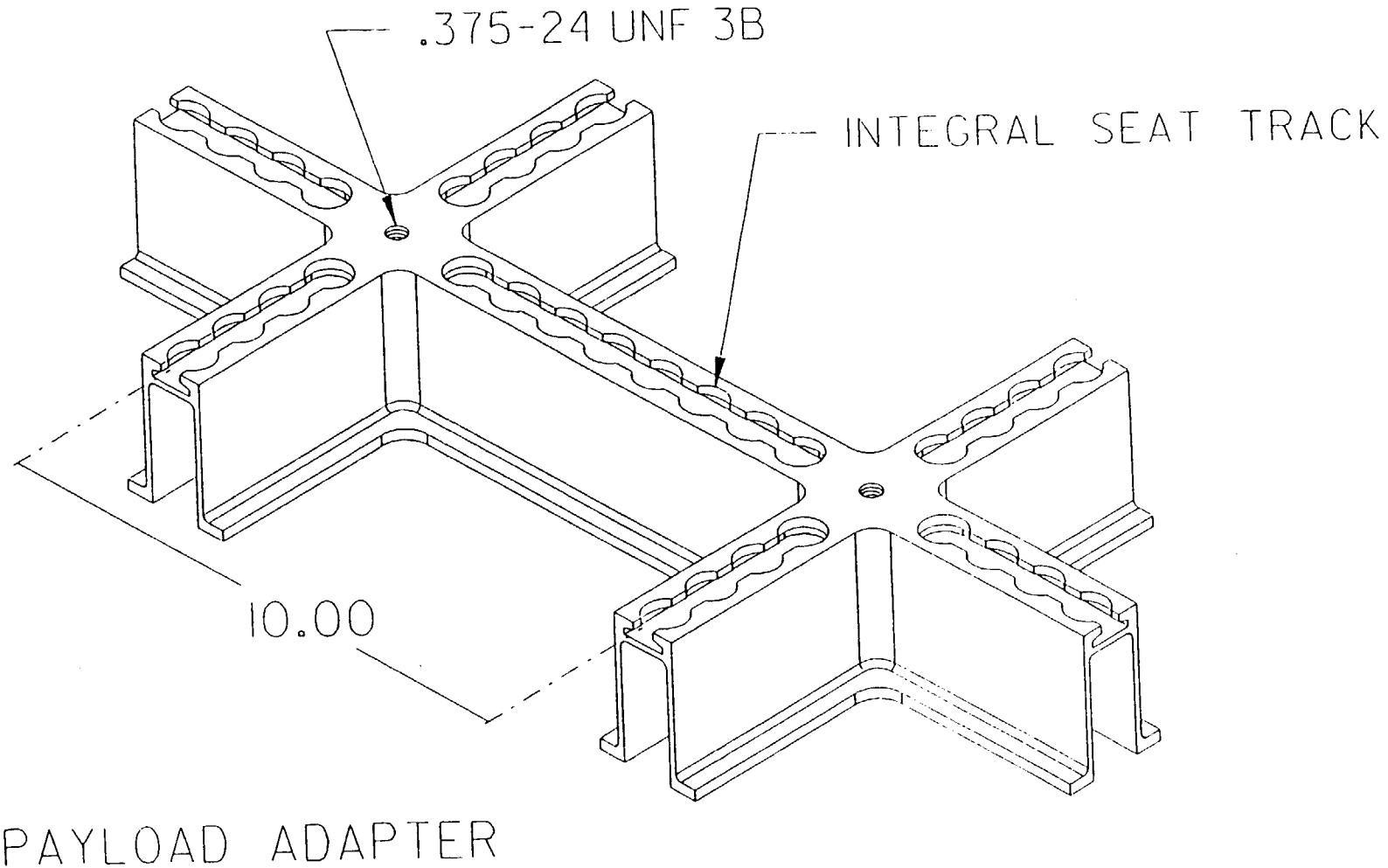
- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



JAC-DWG.BDR-8

MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



MECHANICAL

- EXPRESS PALLET - GROUND DEMONSTRATION BDR

PALLET/ADAPTER INTERFACE

ALIGNMENT GUIDES

OPTIONAL CORNER BOLTS FOR OPTICAL STABILITY AND/OR LAUNCH LOADS

CONICAL ALIGNMENT SURFACES FOR "X" - "Y" LOCATION

EVR ACTUATED ATTACH SCREW

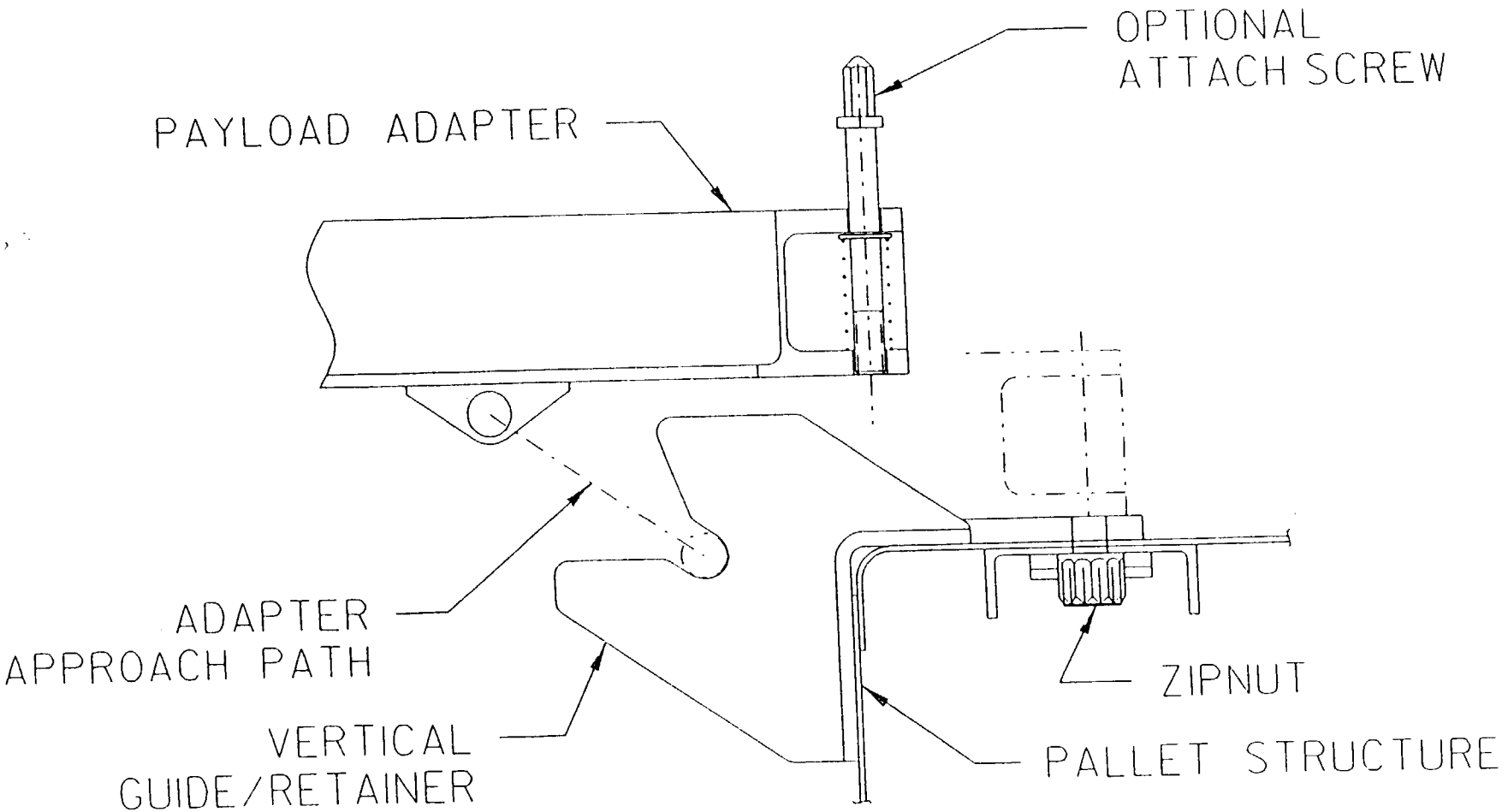
FLOATING BLIND-MATE POWER AND DATA CONNECTORS

EVR ACTUATED CONNECTOR ENGAGEMENT

ATTACHMENT INTERFACE UNIT REPLACABLE BY EVA (DEPENDANT ON WIRE HARNESS)

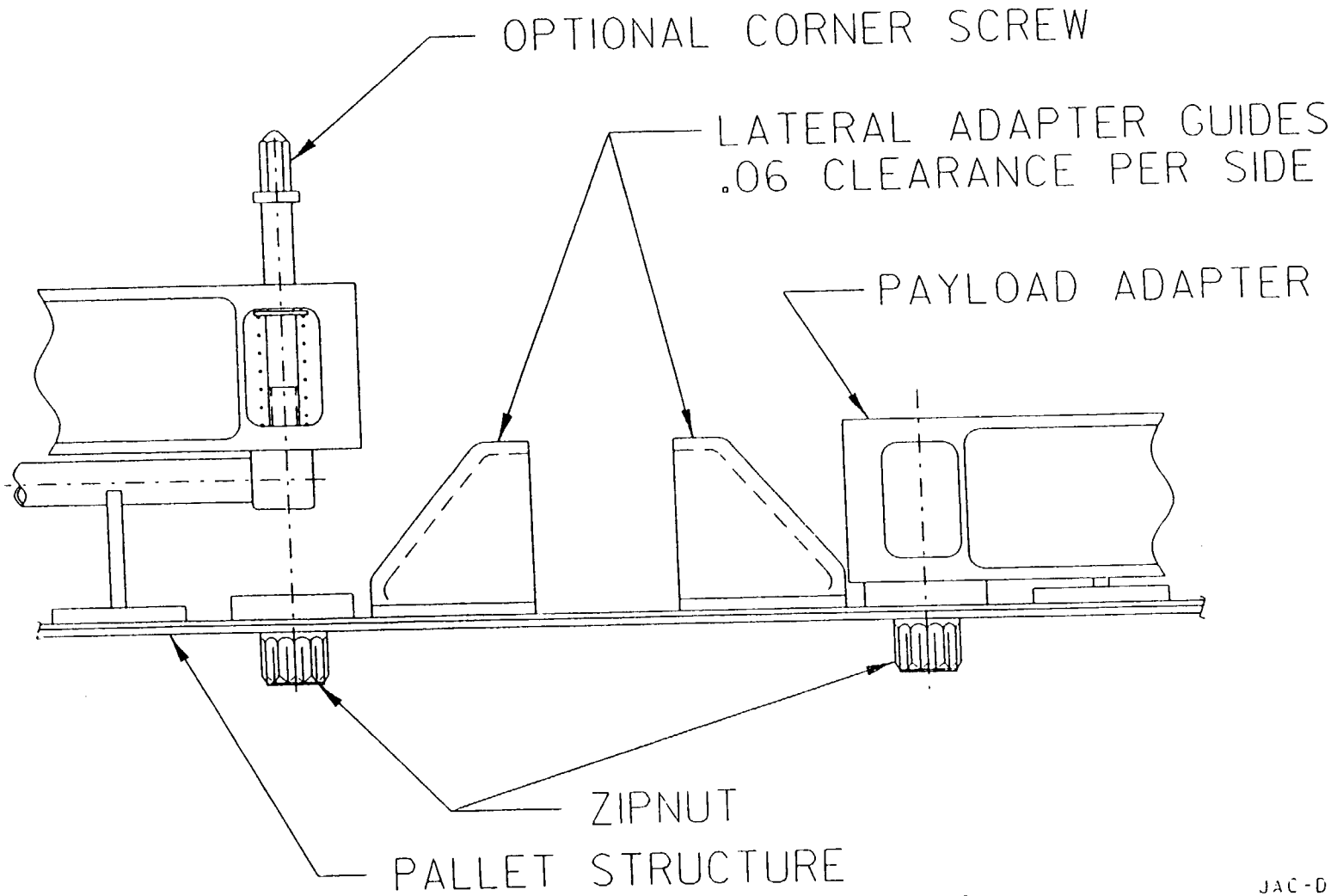
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



MECHANICAL

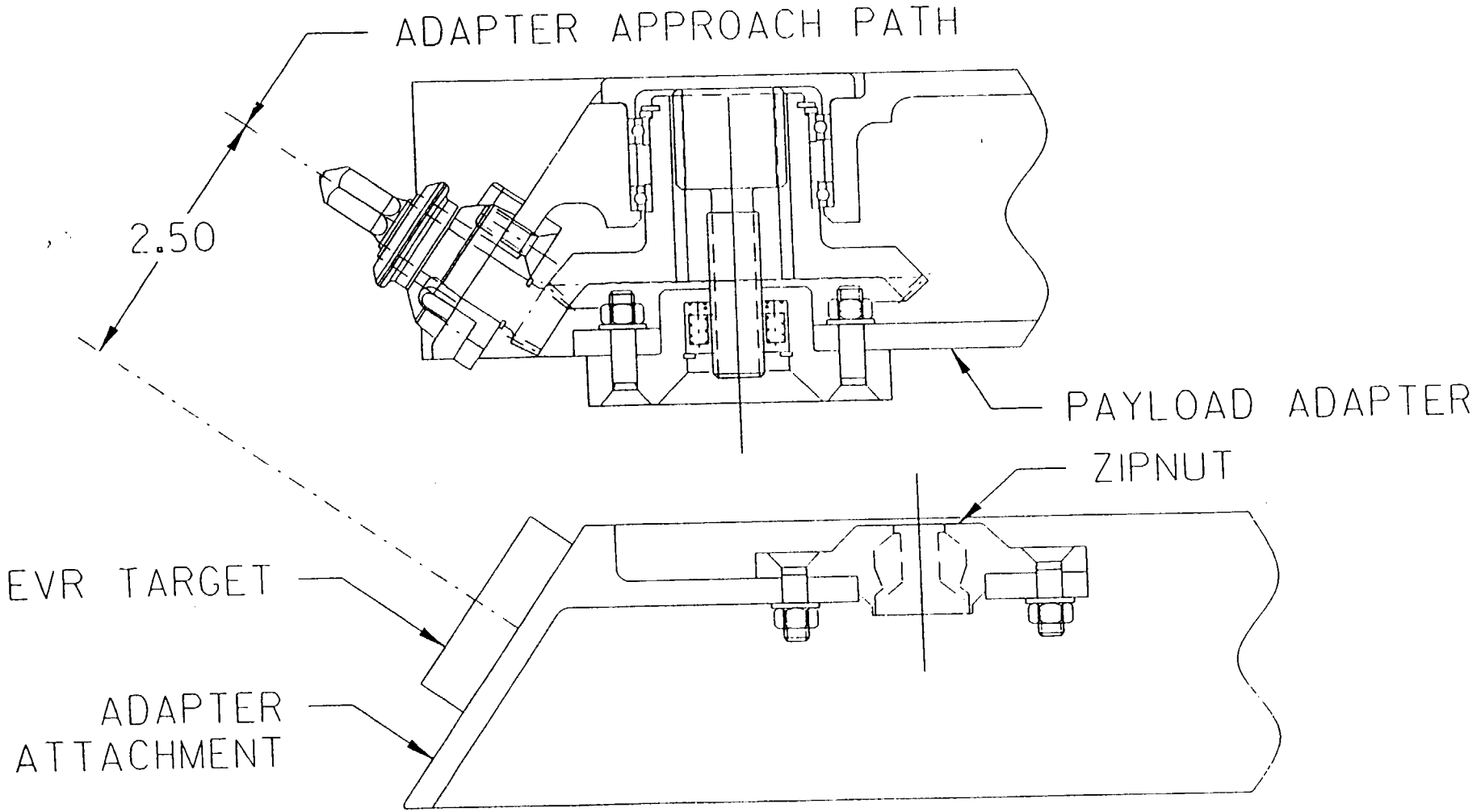
- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



JAC-DWG.BDR-12

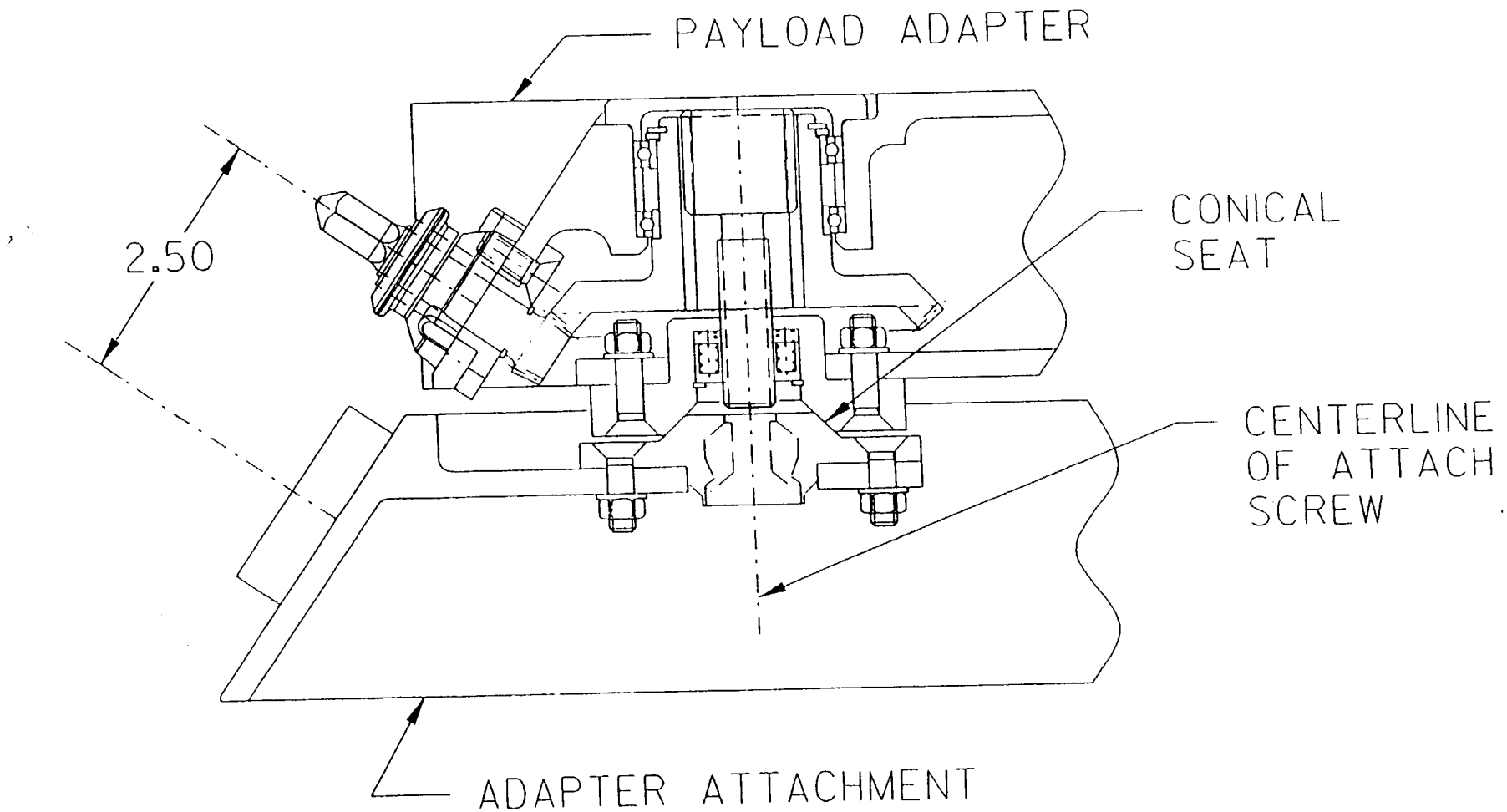
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



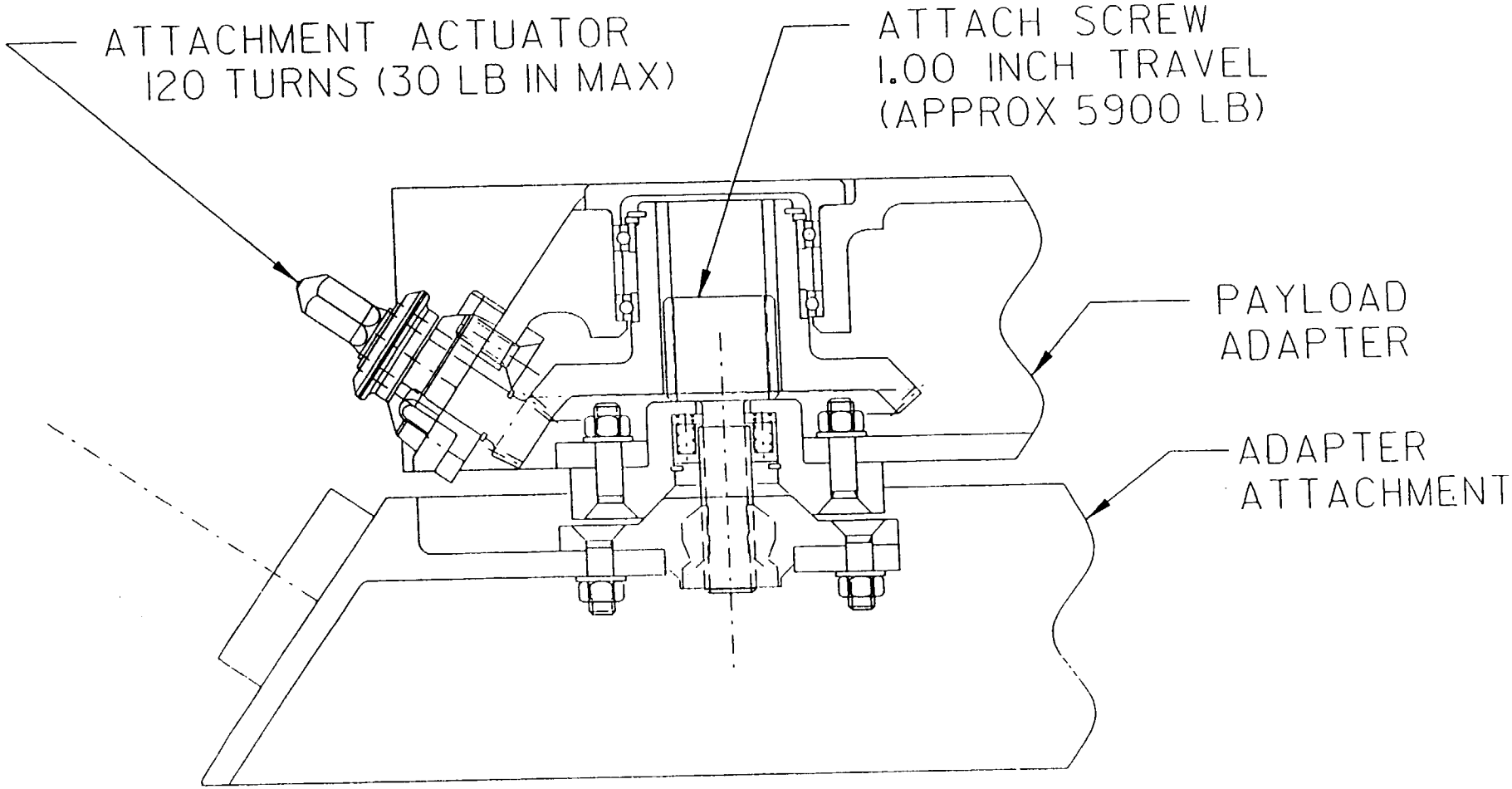
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



MECHANICAL

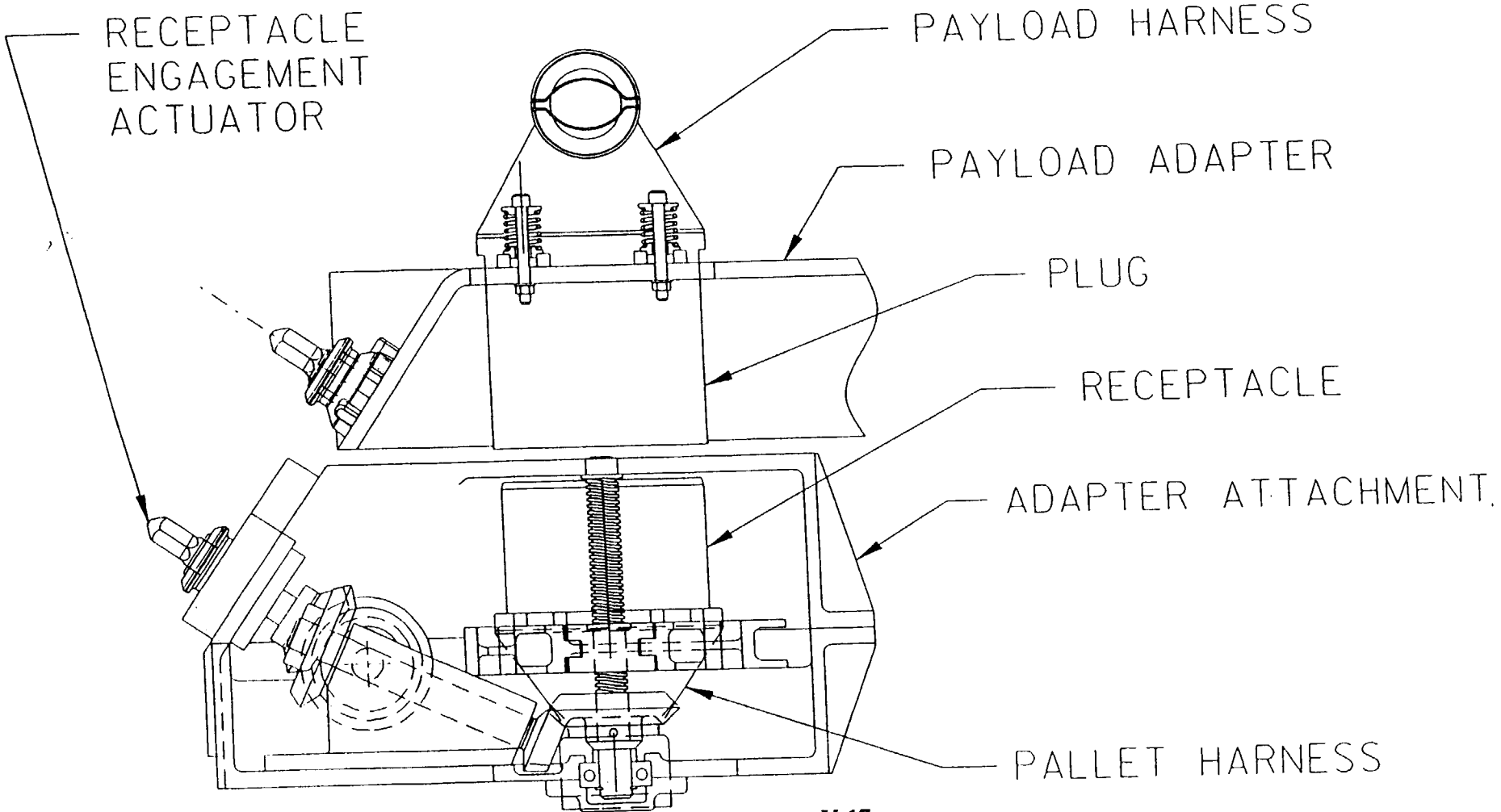
- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



JAC-DWG.BDR-15

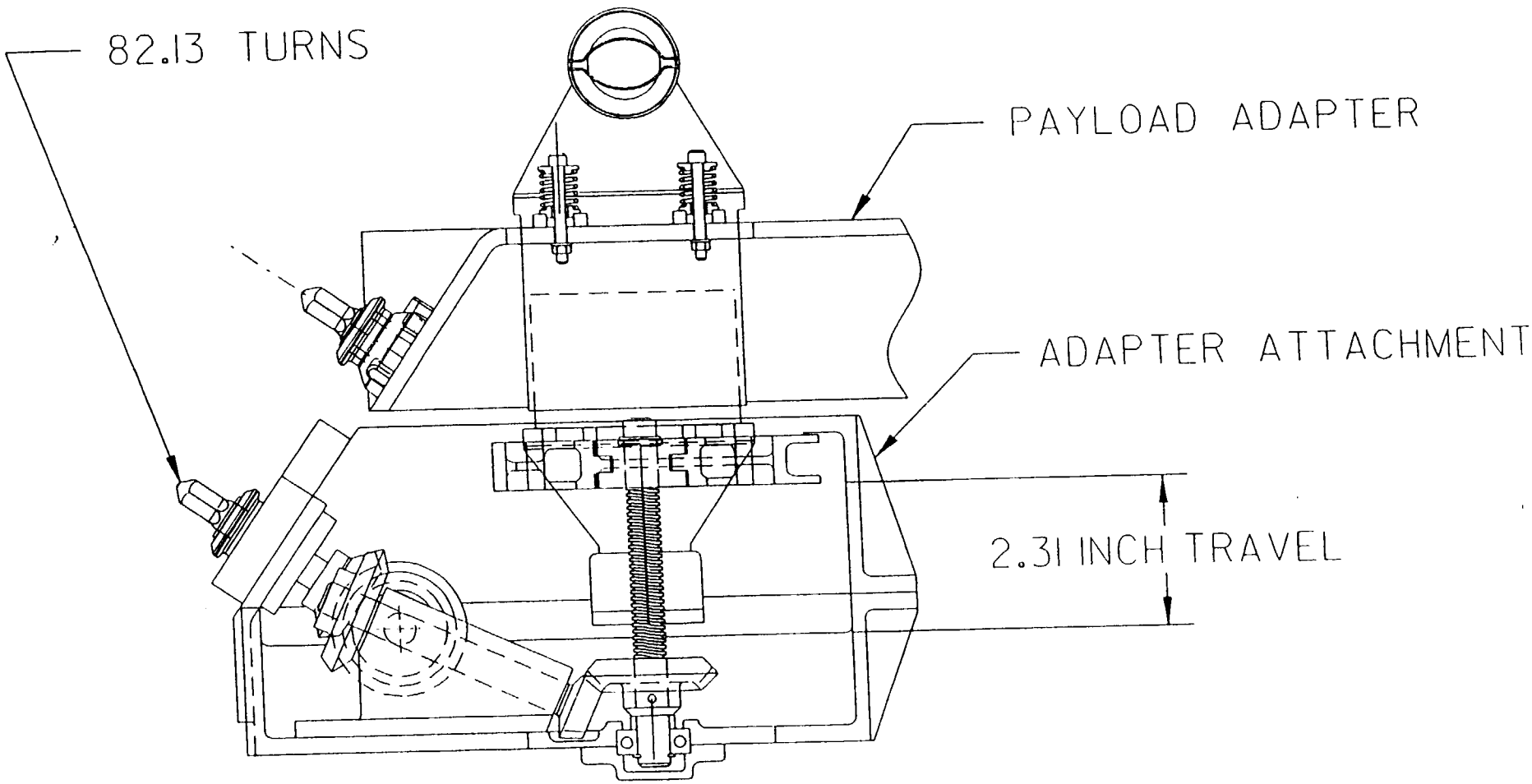
MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

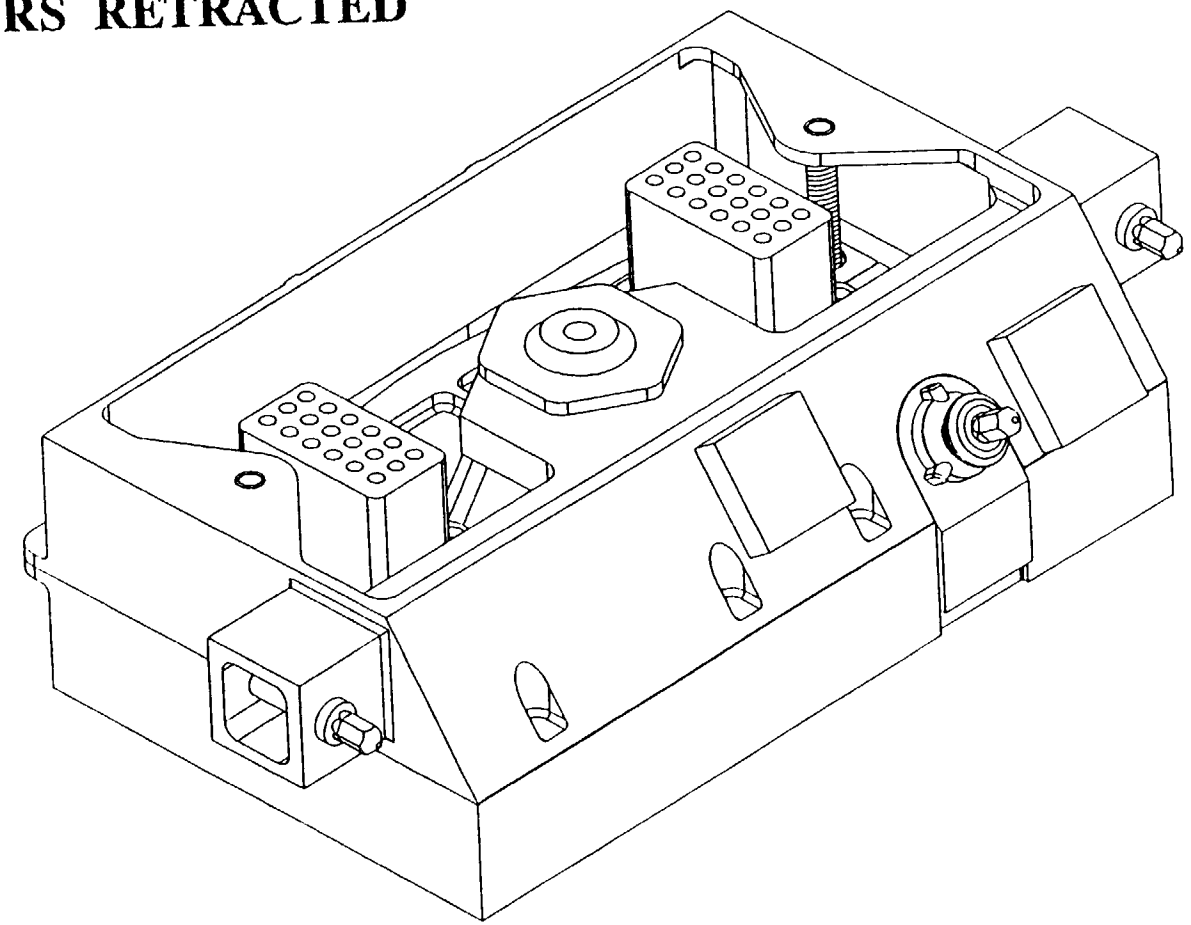


MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

INTERNATIONAL SPACE STATION

CONNECTORS RETRACTED



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

INTERNATIONAL SPACE STATION

PALLET STRUCTURE

CENTRAL "TUBE" CONSTRUCTION FOR LIGHT WEIGHT AND MAXIMUM STIFFNESS

MACHINED FRAMES FOR ADAPTER ATTACHMENT INTERFACE UNIT SUPPORT

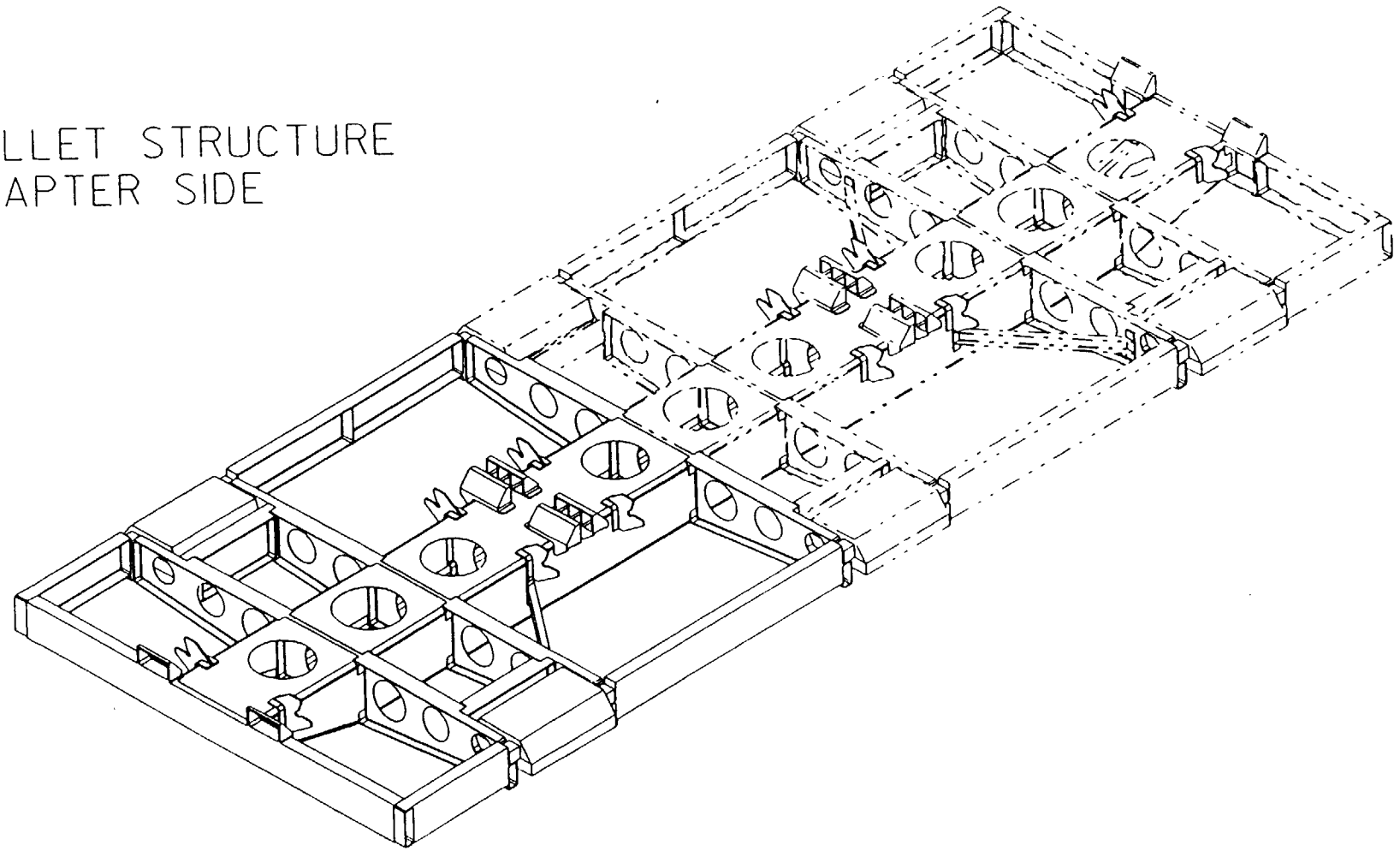
MACHINED BULKHEADS FOR STUCTURAL STIFFNESS AND ATTACHMENT HARDPOINTS

SURROUND STRUCTURE FOR EVA HARDWARE ATTACHMENT

MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

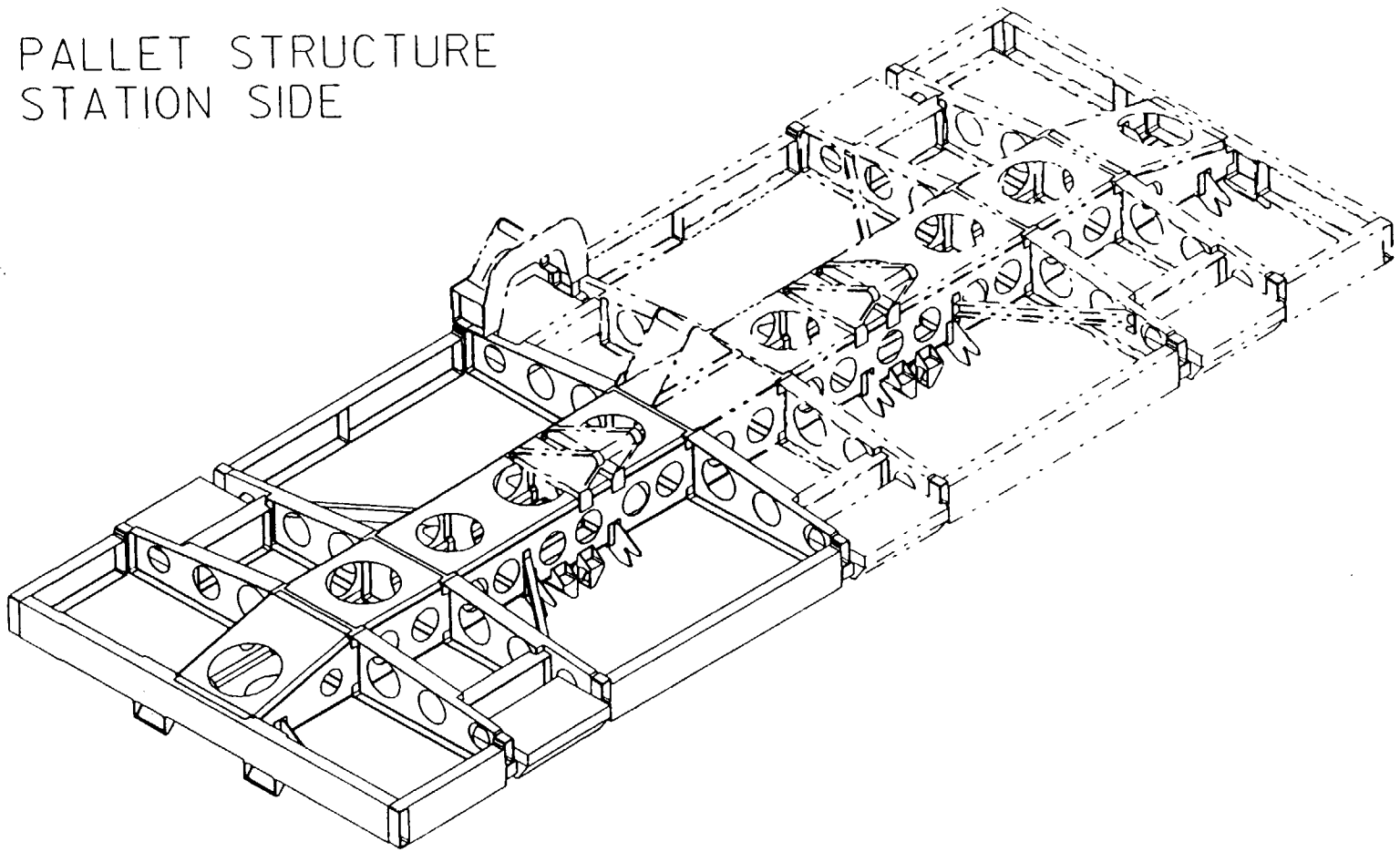
PALLET STRUCTURE
ADAPTER SIDE



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

PALLET STRUCTURE
STATION SIDE



MECHANICAL

- EXPRESS PALLET -
GROUND DEMONSTRATION BDR

INTERNATIONAL SPACE STATION

GROUND DEMO DESIGN PHILOSOPHY:

DESIGN FOR MAX STRENGTH WITHIN PRELIMINARY WEIGHT RESTRICTIONS (ADAPTER 100 LB, PALLET 1000LB)

UTILIZE LOAD FACTORS OF 6G IN THE X AND Z DIRECTIONS AND 2G IN THE Y DIRECTION (SHUTTLE COORDINATE SYSTEM)



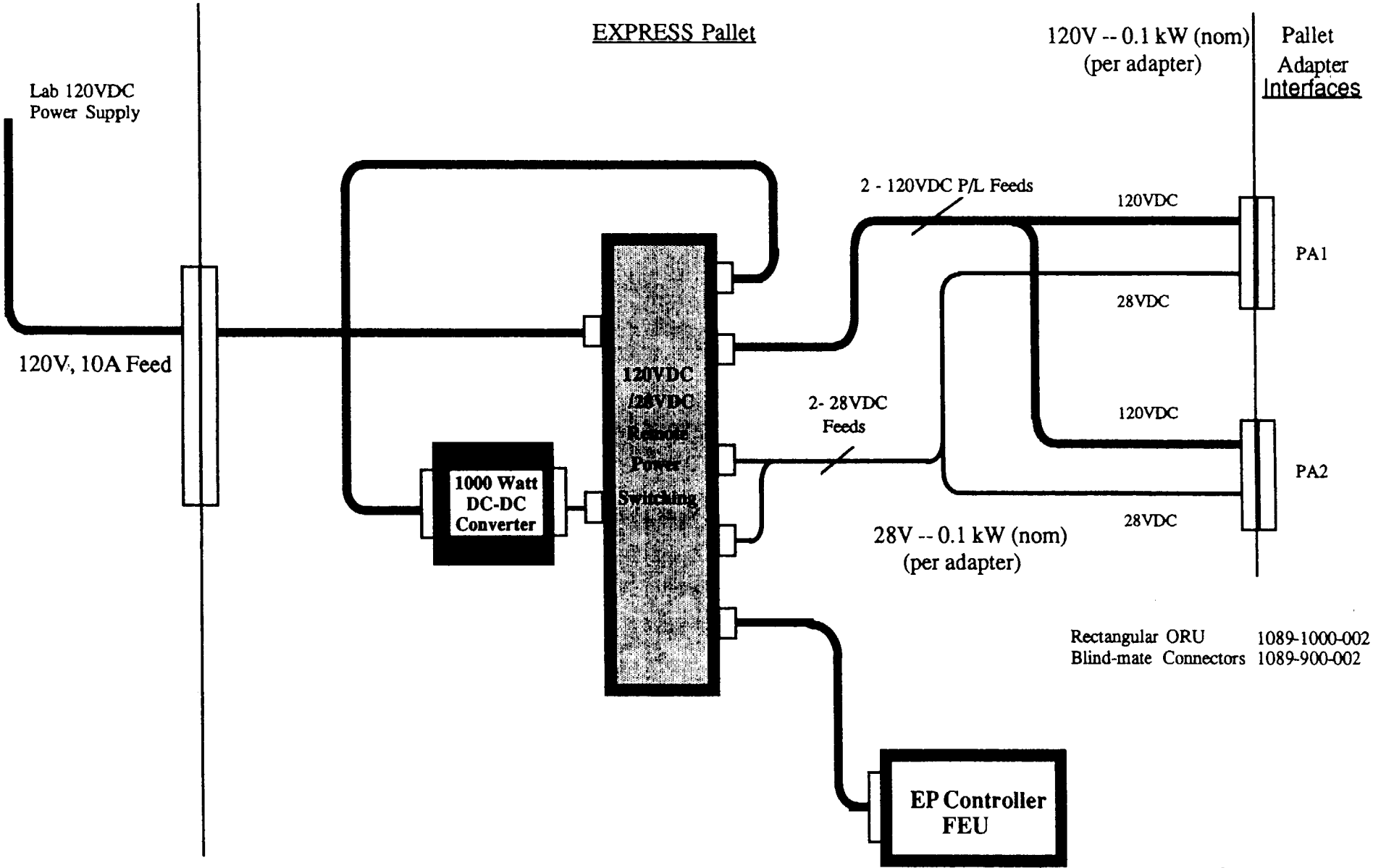


Section VI
Electrical Power System

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Brad McCall

EXPRESS Pallet
Preliminary Ground Demonstration Power Architecture



Rectangular ORU 1089-1000-002
Blind-mate Connectors 1089-900-002

EXPRESS Pallet

Preliminary Ground Demonstration Power Architecture

- 120VDC Capability
 - * Furnished from bench power supply (1kW)
 - * 2 feeds per adapter – 1 Amp (typ), 6 Amps (max)
 - * Direct coupled from terminal jumpers
- 28VDC Capability
 - * Provided from GFP power converter
 - * 2 feeds per adapter – 4 Amp (typ), 20 Amps (max)
 - * Connected through discrete controlled switches
- Grounding Capability through ground fault line to power supply and converter

EXPRESS Pallet Ground Demo Adapter Connectors

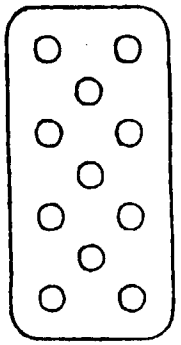
Power Connector

120VDC, 1A (nom) Feed #1 (Pwr, Rtn 120VDC Common Gnd)

120VDC, 1A (nom) Feed #2 (Pwr, Rtn, 120VDC Common Gnd)

28VDC, 4A (nom) Feed #1 (Pwr, Rtn, 28VDC Common Gnd)

28VDC, 4A (nom) Feed #2 (Pwr, Rtn, 28VDC Common Gnd)



11 - #4

P/N 1089-1000/900-002 (SSQ 22680)





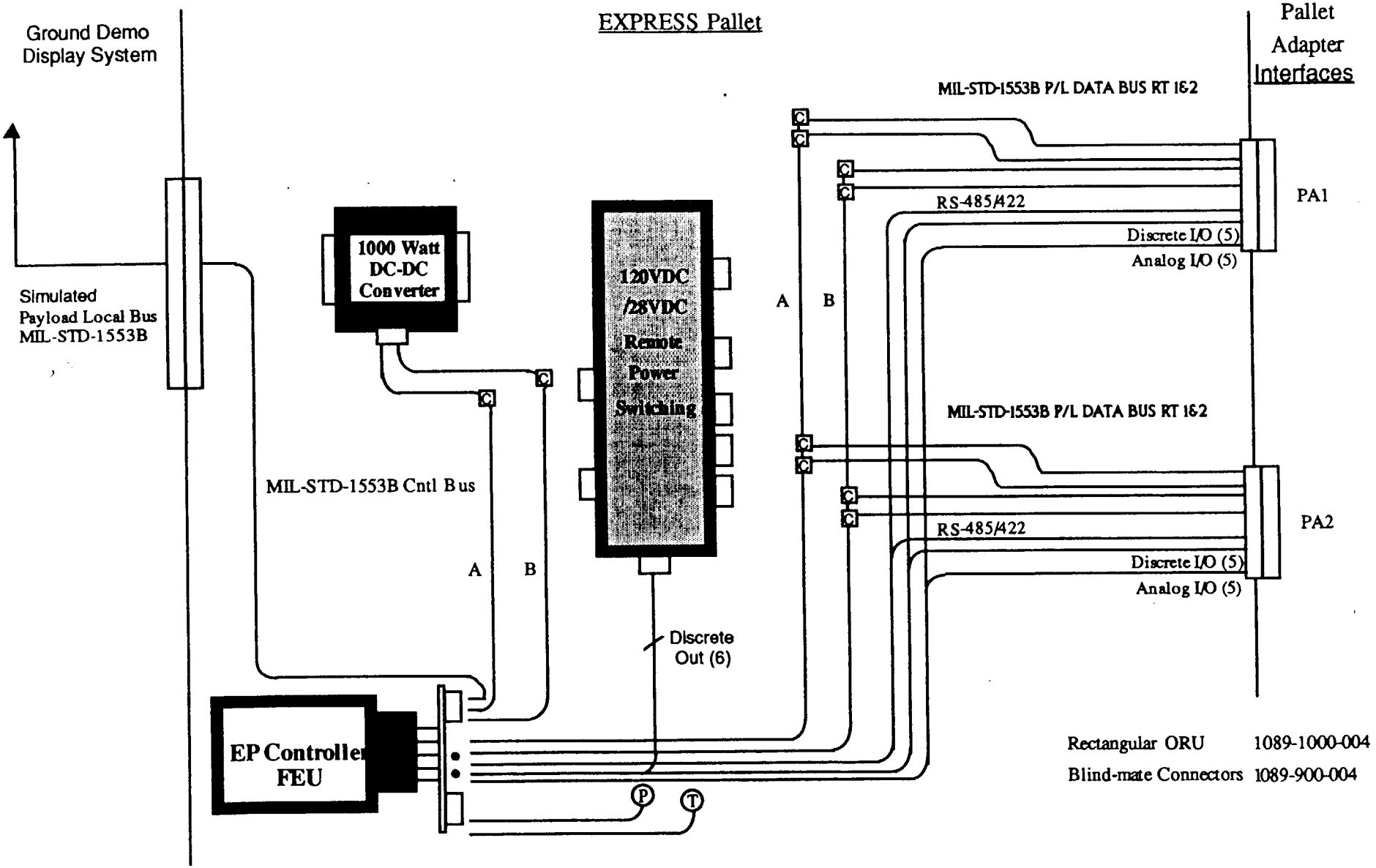
Section VII
Data System

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Brad McCall

EXPRESS Pallet

Preliminary Ground Demonstration Data Architecture



NASA/Boeing

EXPRESS Pallet Ground Demo Data Interface Summary

Interface	Description	Protocol	Remarks
Discrete	Discrete I/O	N/A	Discrete I/O can accommodate passive (+15VDC) or active loads (+5 to 32VDC).
High Level Analog (HLA)	Analog input with 12 bit resolution (1 sign bit, 11 magnitude bits)	N/A	High level analog can accommodate preconditioned (+/- 5VDC diff) or 4 to 20 ma current loop sensors (e.g. pressure, etc.) with +15VDC excitation available..
Low Level Analog (LLA)	Analog input with 12 bit resolution (1 sign bit, 11 magnitude bits)	N/A	Low level analog can accommodate preconditioned (+/- 5VDC diff) or RTD current loop sensors (e.g. pressure, etc.) with 1mA excitation and selectable gains/offsets available
MIL-STD-1553B	Redundant, Bi-phase, 1 Mb/s Bidirectional Serial Interface	Subaddress Mapped Commands/Statuses	Specific command/status subaddress assignments not yet determined. Dependent on experiment requirements.
RS 485/422	Balanced Differential 19.6 Kb/s Bidirectional Serial Interface (two wire pairs)	Similar to Common Berthing Mechanism	Multidrop implementation planned. Detailed protocol and physical topology under study.

EXPRESS Pallet

Discrete Interface

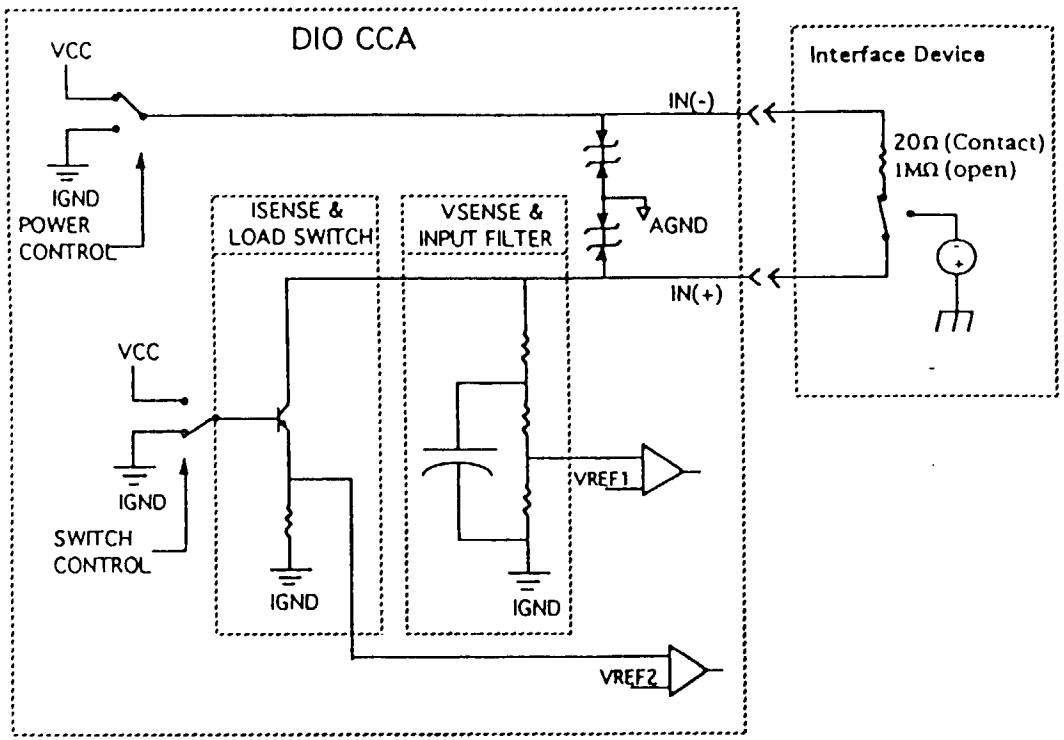
EXPRESS Pallet Interface Definition
Discrete Interface

- **General Characteristics**
 - **32 channels (with returns)**
 - **4 modes of operation**
 * **Discrete Input - Active Source**
 * **Discrete Input - Passive Source**
 * **Discrete Output - External Power**
 * **Discrete Output - Internal Power**

EXPRESS Pallet Interface Definition
Discrete Interface

- **Discrete Input - Passive Source**
 - **Provide isolated +15VDC, 0.13 mA (typ) source (for switch/solenoid excitation)**
 - **"1" state (switch closed): <20 Ohms (between pins)**
 - **"0" state (switch open): >1MOhm (between pins)**
 - **Input Impedance: >125KOhm (between pins)**
 - **ESD Protection: 4KOhm (min)**
 - **Leakage current: <1uA**
 - **Short circuit/Overvoltage protection**
 - **Noise filtering: time constant = 1.0 ms**

EXPRESS Pallet Interface Definition
Discrete Interface



Discrete Input - Passive Source Block Diagram

EXPRESS Pallet

High Level Analog (HLA) Interface

EXPRESS Pallet Interface Definition
High Level Analog (HLA)

o General Characteristics

- 32 channels (with returns)

- 4 modes of operation

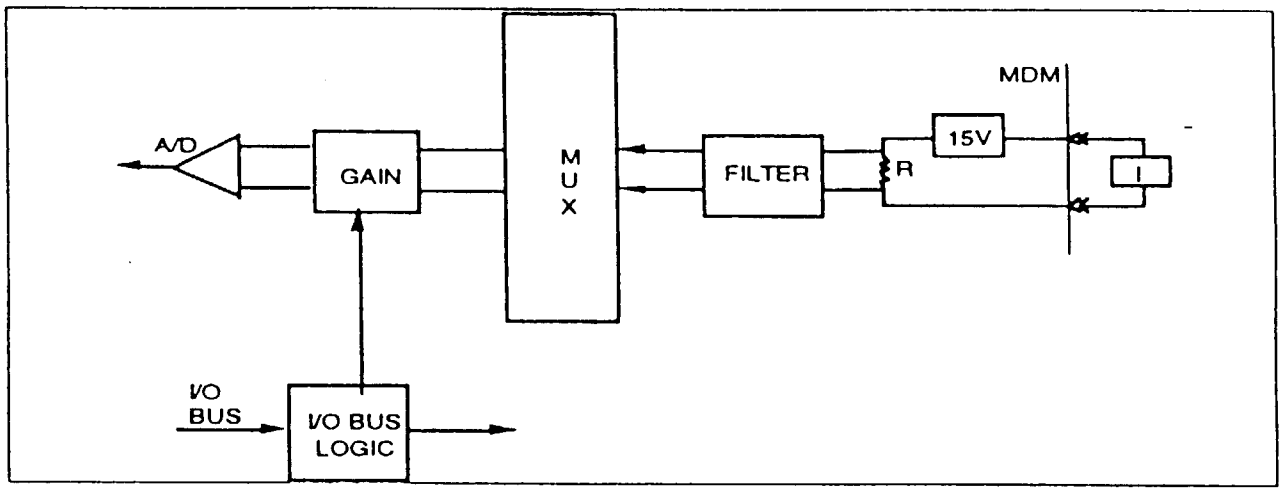
 * Passive Current Loop
 * Active Current Loop
 * Voltage Input
 * Voltage Source

EXPRESS Pallet Interface Definition
High Level Analog (HLA)

o Passive Current Loop

- Current source of 4 to 20mA, 15V (for pressure sensors, etc.)
- A/D resolution: 11 magnitude bits plus sign bit
- Output Impedance: 16.3Ohm
- Current sense resistor: 250Ohm
- Channel accuracy: +/- 1.0%
- Load Capacitance: 5.3 uF (max)
- ESD Protection: 4KOhm (min)
- Noise filtering: Single pole, low pass, 160Hz
- Short circuit protection

EXPRESS Pallet Interface Definition
High Level Analog (HLA)



HLA - Passive Current Loop Block Diagram

EXPRESS Pallet

Low Level Analog (LLA) Interface

EXPRESS Pallet Interface Definition
Low Level Analog (LLA)

o General Characteristics

- 32 channels (with returns)

- 3 modes of operation

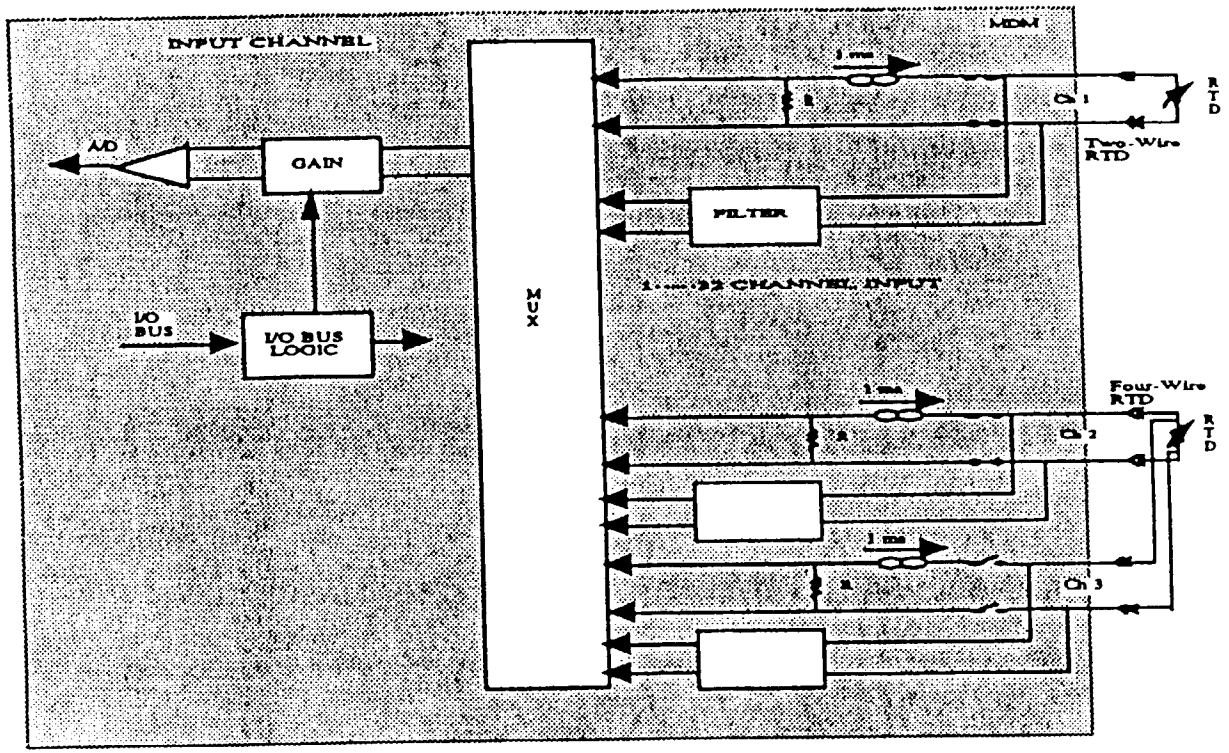
 * Current Loop (CL)
 * Voltage Input (VI)
 * 4-wire RTD (CL/VI Combination)

EXPRESS Pallet Interface Definition
Low Level Analog (LLA)

o Current Loop

- Constant current source of 1mA (for resistive element excitation, i.e. RTDs)
- A/D resolution: 11 magnitude bits plus sign bit
- Selectable gains: 10, 2.5, 1
- Selectable offsets (@ G=10): 1.5V, 1.0V, 0.5V, 0V
- Input Impedance: 100KOhm (min)
- CL accuracy: +/- 0.3%
- Noise filtering: Single pole, low pass, 160Hz
- Short circuit protection

EXPRESS Pallet Interface Definition
Low Level Analog (LLA)



LLA - Current Loop (2-wire, 4-wire RTD) Block Diagram

EXPRESS Pallet Interface Definition
Low Level Analog (LLA)

RTD	Gain	Offset	Temp. Range	Error
100	10	0	-405 to +2237	± 26.4
250	10	0	-405 to +502	± 9.1
250	10	0.5	-405 to +1585	± 10.8
250	10	1.0	+502 to +3021	± 14.4
500	10	0	-405 to +32	± 4.4
500	10	0.5	-405 to +502	± 4.7
500	10	1.0	+32 to +1015	± 5.1
500	10	1.5	+502 to +1585	± 5.7
1000	1	N/A	-405 to +2237	± 25.4
1000	10	0	-405 to -189	± 1.8
1000	10	0.5	-405 to +32	± 1.8
1000	10	1.0	-189 to +262	± 1.8
1000	10	1.5	+32 to +502	± 1.8
2000	1	N/A	-405 to +753	± 11.6
2000	10	0	-405 to -295	± 1.1
2000	10	0.5	-405 to -189	± 1.1
2000	10	1.0	-295 to -80	± 1.1
2000	10	1.5	-189 to +32	± 1.1

LLA - 2-Wire RTD Measurement Table

EXPRESS Pallet

MIL-STD-1553B Interface

EXPRESS Pallet Interface Definition
MIL-STD-1553B

- **Functional Characteristics**

 - **3 interfaces**
 - * **1 Payload local bus RT**
 - * **2 configurable busses (BC, RT, monitor) used as BCs**

 - **Broadcast time synchronization once per second**

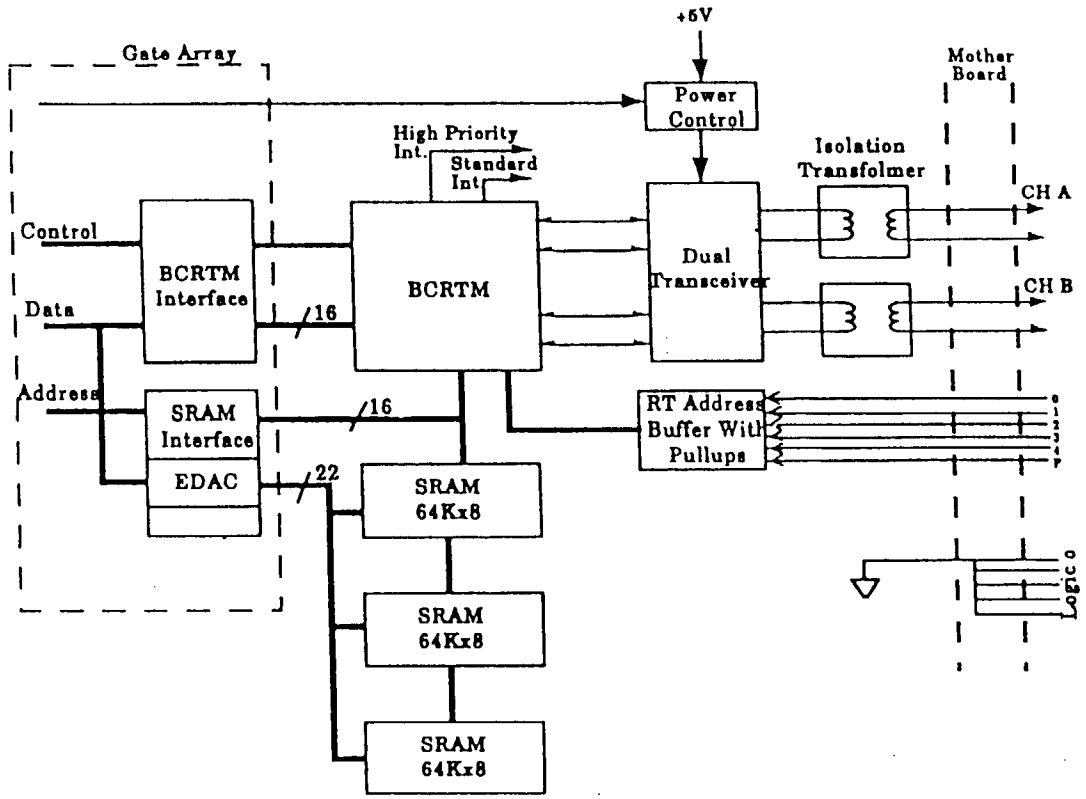
 - **Automatic message retry (# selectable) (on interface A or B) for no RT response or message error**

 - **Maximum signaling rate: 1Mb/s**

 - **Maximum data transmission rate: <800 Kb/s**

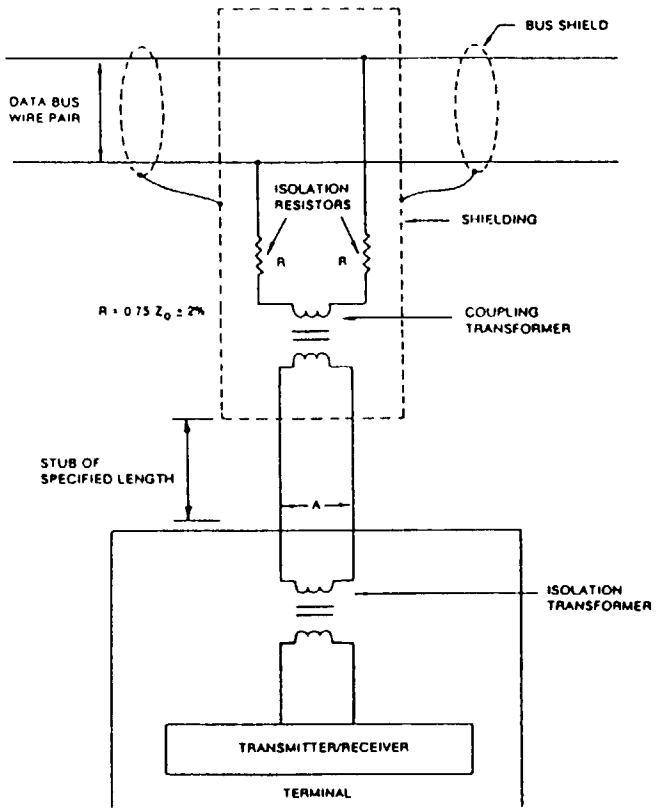
 - **Bit error rate of 1 in 10E(7)**

EXPRESS Pallet Interface Definition
MIL-STD-1553B

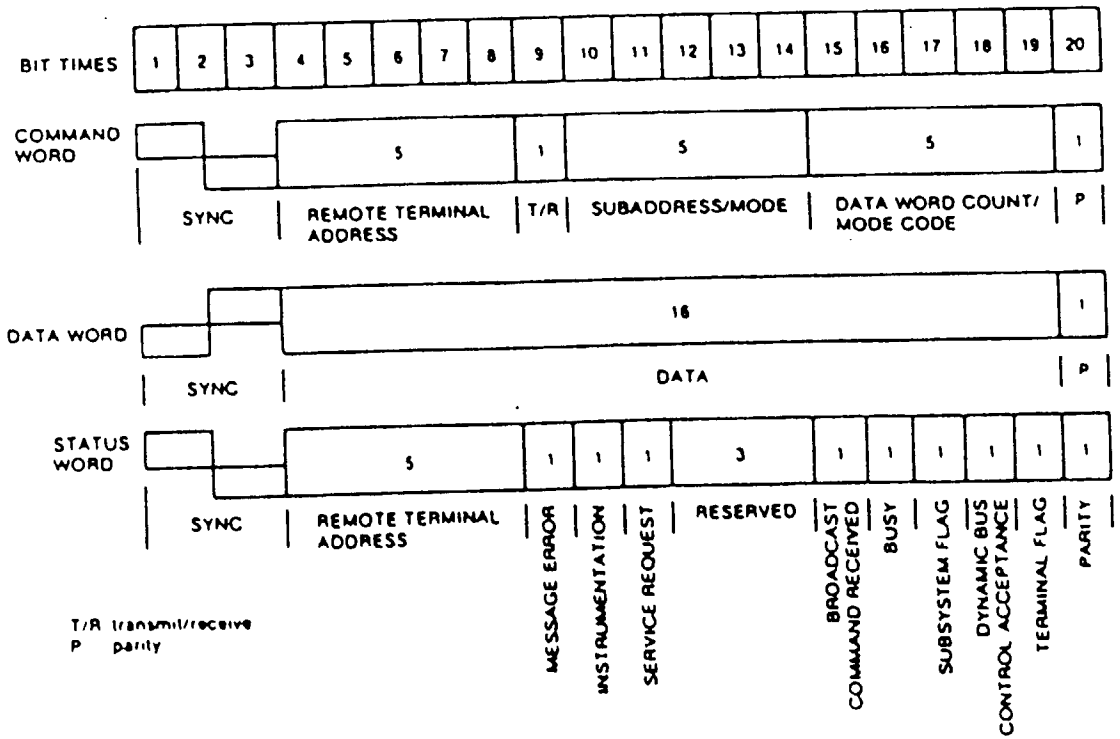


MIL-STD-1553B Block Diagram

EXPRESS Pallet Interface Definition
MIL-STD-1553B



MIL-STD-1553B Transformer Coupled Bus Configuration



MIL-STD-1553B Standard Word Formats

Command /Status word	**Word 1**
Data word 1 (optional)	**Word 2**
•	
•	
Data word 30 (optional)	**Word 31**
Checksum	**Word 32**

EXPRESS Pallet MIL-STD-1553B Message Format

EXPRESS Pallet

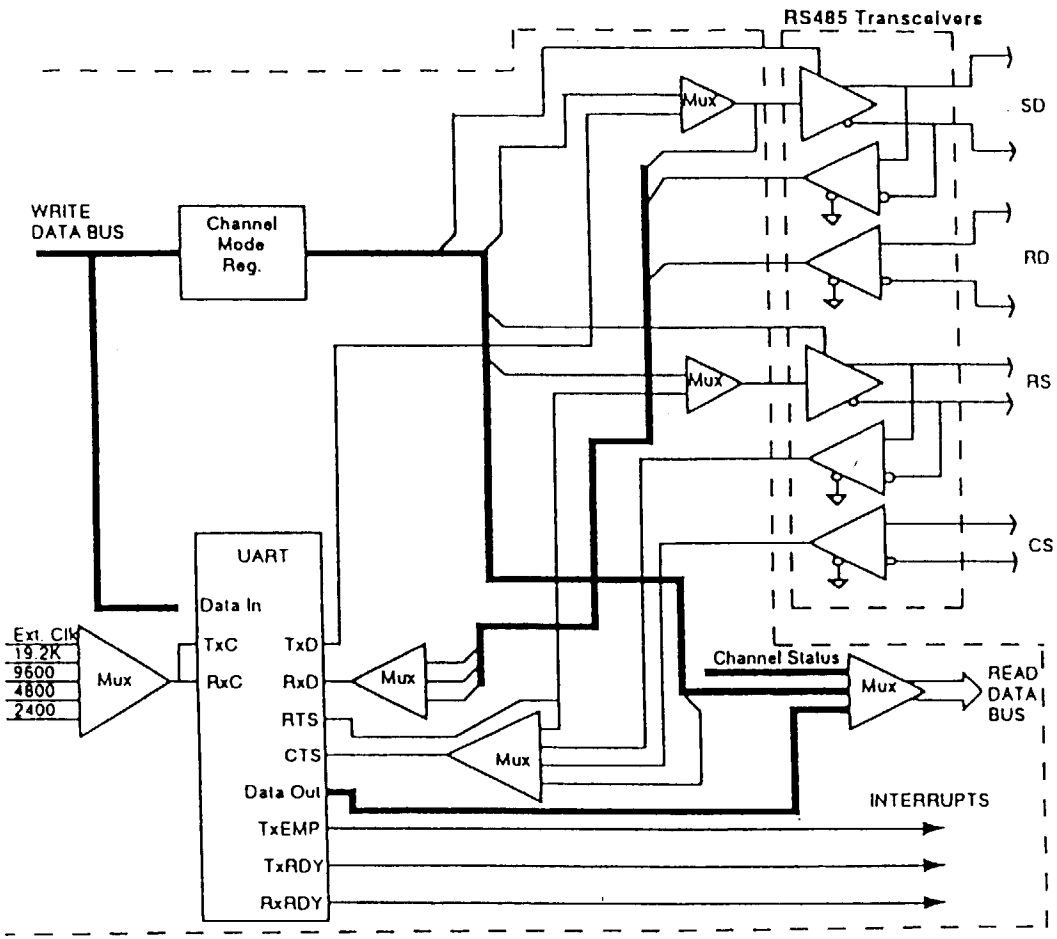
EIA RS-422/485 Interface

EXPRESS Pallet Interface Definition
EIA RS-422/485

- Communication Characteristics

 - Conforms to RS-449 data and timing configuration
 - * Control Signals: Clear To Send (CTS), Ready To Send (RTS)
 - * Data signals: Send Data (SD), Receive Data (RD)
 - * Cable (TSP) cable length: 200 ft (max)
 - Bit Rates: 2.4K, 4.8K. 9.6K, 19.2K (baud)
 - Word Length: 5, 6, 7, 8 bits
 - Parity: None, even, odd
 - Stop Bits: 1, 1.5, 2
 - Duplex: Half or Full

EXPRESS Pallet Interface Definition
EIA RS-422/485

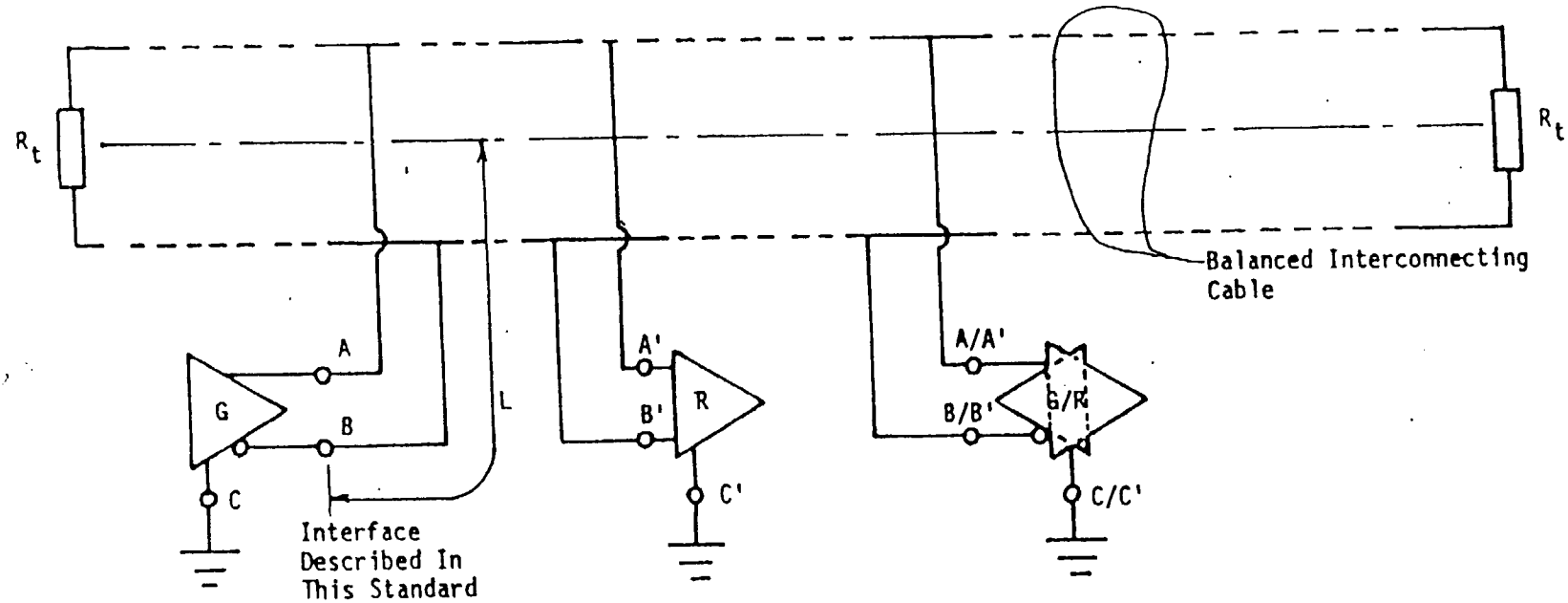


EIA RS-422/485 Serial Interface Block Diagram

EXPRESS Pallet Interface Definition
EIA RS-422/485

- Point-to-point implementation (RS-422)
- Multipoint implementation (RS-485)
 - Use PG3 developed protocol for Common Berthing Mechanisms
 - Master/Slave, "daisy-chain" topology
 - 30 slaves max, 2 slaves per adapter (typical)
 - Half Duplex Operation
 - 11 bit Data Frame
 - * "0" Start Bit
 - * 8 data /address bits
 - * 9th bit for Byte Type ("1" for address bytes/"0" for data bytes)
 - * "1" Stop Bit
 - Message Size of 5 to 14 Data Frames
 - 19.2Kbaud (higher rates under study)
 - Error Control: Framing Error & Checksum Error

EXPRESS Pallet Interface Definition
EIA RS-422/485



G - Generator
R - Receiver
G/R- Combination Generator/Receiver
L - Length of stub; the guidelines assume length of stub to be effectively zero.
R_t- Termination resistance; location and value are not specified in this standard, but a generator can drive 32 unit loads plus two termination resistances of 120 ohms each.

EIA RS-485 Topology

EXPRESS Pallet Interface Definition
EIA RS-422/485

- Multidrop implementation (RS-485) (cont.)
 - Command Message (5 Data Frames - minimum)
 - * 1st Frame: Slave Address
 - * 2nd Frame: Number of data bytes in message
 - * 3rd Frame: Command Code
 - * 4th-12th Frames: Optional data frames for command parameters
 - * 13th-14th Frame: Checksum of Frames 1 through 13.
 - Response Message
 - * 1st Frame: Slave Address
 - * 2nd Frame: Number of data bytes in message
 - * 3rd Frame: Response Status Code
 - * 4th-12th Frames: Optional data frames for status parameters
 - * 13th-14th Frame: Checksum of Frames 1 through 12

NOTE: Command and Status Code definition are TBD

Slave Address	Frame #1
Number of bytes in message (command/status code + data bytes)	Frame #2
Command/Response Status Code	Frame #3
Optional data byte #1 for command/status parameters	Frame #4
*	
*	
*	
Optional data byte #9 for command/status parameters	Frame #12
Checksum MSB	Frame #13
Checksum LSB	Frame #14

EIA RS-485 Message Format

EXPRESS Pallet Ground Demo Adapter Connectors

Data Connector

MIL-STD 1553B RT#1 (A, A rtn, B, B rtn)

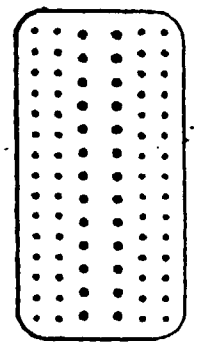
MIL-STD 1553B RT#2 (A, A rtn, B, B rtn)

RS485/422 #1 (CTS+, CTS-, RTS+, RTS-, SD+, SD-, RD+, RD-)

RS485/422 #2 (CTS+, CTS-, RTS+, RTS-, SD+, SD-, RD+, RD-)

5 - High Level Analog / Low Level Analog I/Fs (Signal, Rtn)

5 - Discrete I/O (Signal, Rtn)



26 - #16
60 - #20

P/N 1089-1000/900-004 (SSQ 22680)





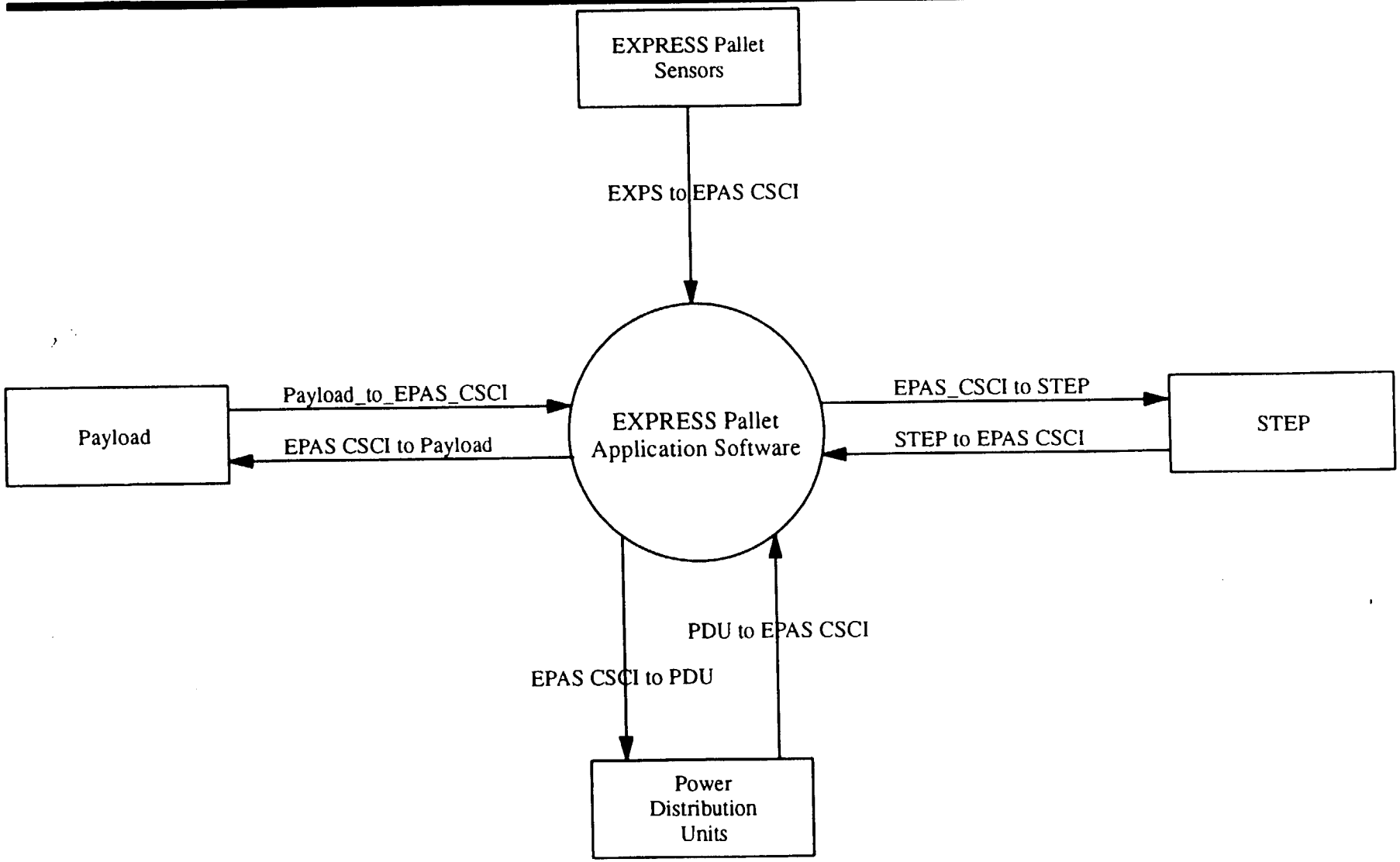
Section VIII
Software

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Vance Davis

EXPRESS Pallet Application Software

External Interfaces





EXPRESS Pallet Application Software

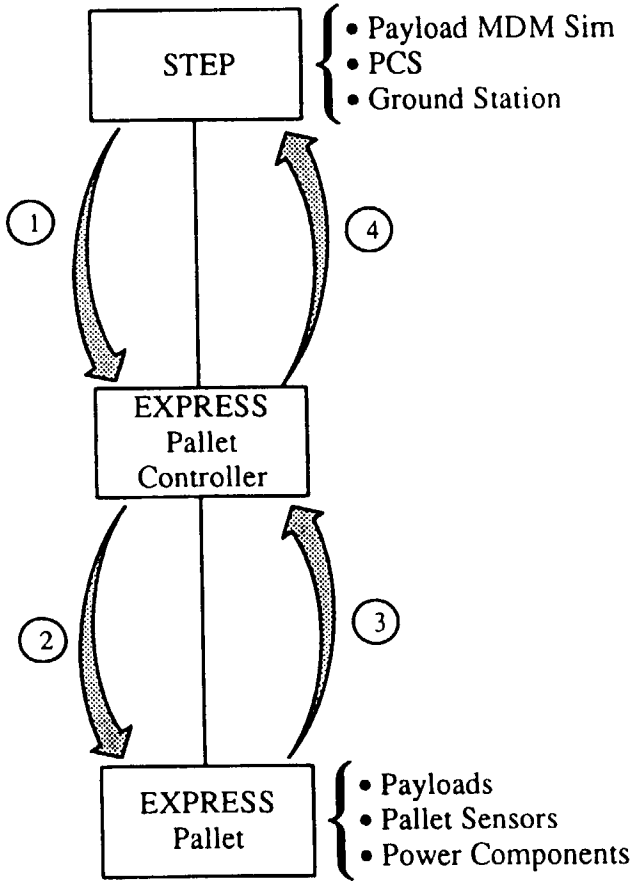
Ground Demonstration Capabilities



- Ancillary Data Service. Provides collection and distribution of ancillary data to payloads and the ground.
- Exception Monitoring. Provides monitoring and response to out–of–limit conditions on data.
- Health and Status. Provides collection and distribution of payload and payload related equipment status. Downlink status data to the ground station.
- Low Rate Telemetry Service. Collects payload science data upon request and routes to the ground station.
- Payload/EPMACS CSCI Operations Control. Route crew/ground/script commands to payloads, control complement operations upon command, and control EXPRESS Pallet CSCI modes upon command.
- Procedure Execution Service. Execution of scripts and provides payloads sequence execution control upon request.

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External Flow



(1) Commands: The payload command generated from the ground station or crew (simulated PCS) contains a CCSDS header with an APID that is uniquely associated with the target payload.

Ancillary Data: Core system data which is to be included in an ancillary data set.

Request Response: Response to a service request from the Payload MDM.

(2) Commands: The EXPRESS Pallet Controller utilizes configuration data to determine the command target based on a APID/Payload Index.

Ancillary Data: Ancillary data provided to the payloads on the EXPRESS Pallet.

Request Response: Response to a service request from the EXPRESS Pallet Controller CSCI.

(3) Health & Status: Payloads, pallet sensors, and power components Health & Status data.

Low Rate Telemetry: Payload low rate telemetry.

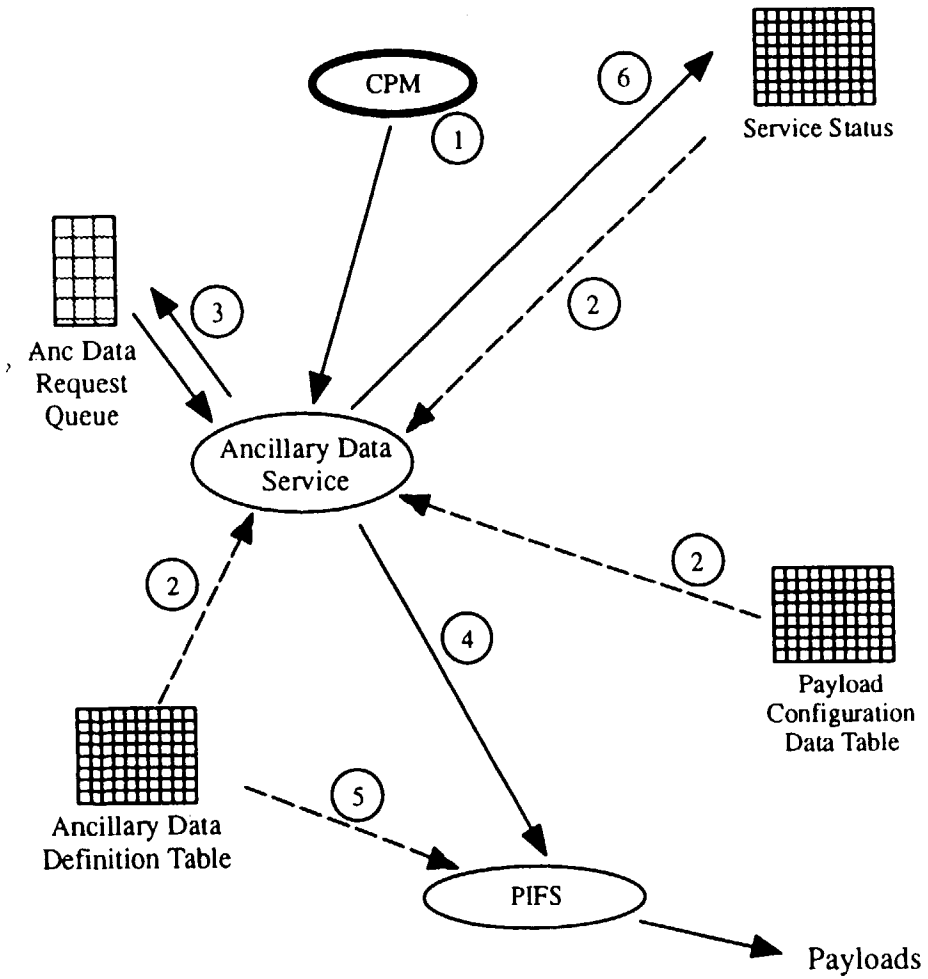
(4) Health & Status: Payloads, pallet sensors, power components, and EXPRESS Pallet Controller Health & Status data.

Low Rate Telemetry: Payload low rate telemetry.

C&W: Caution & Warning generated via the Limit Exception service

EXPRESS Pallet Application Software

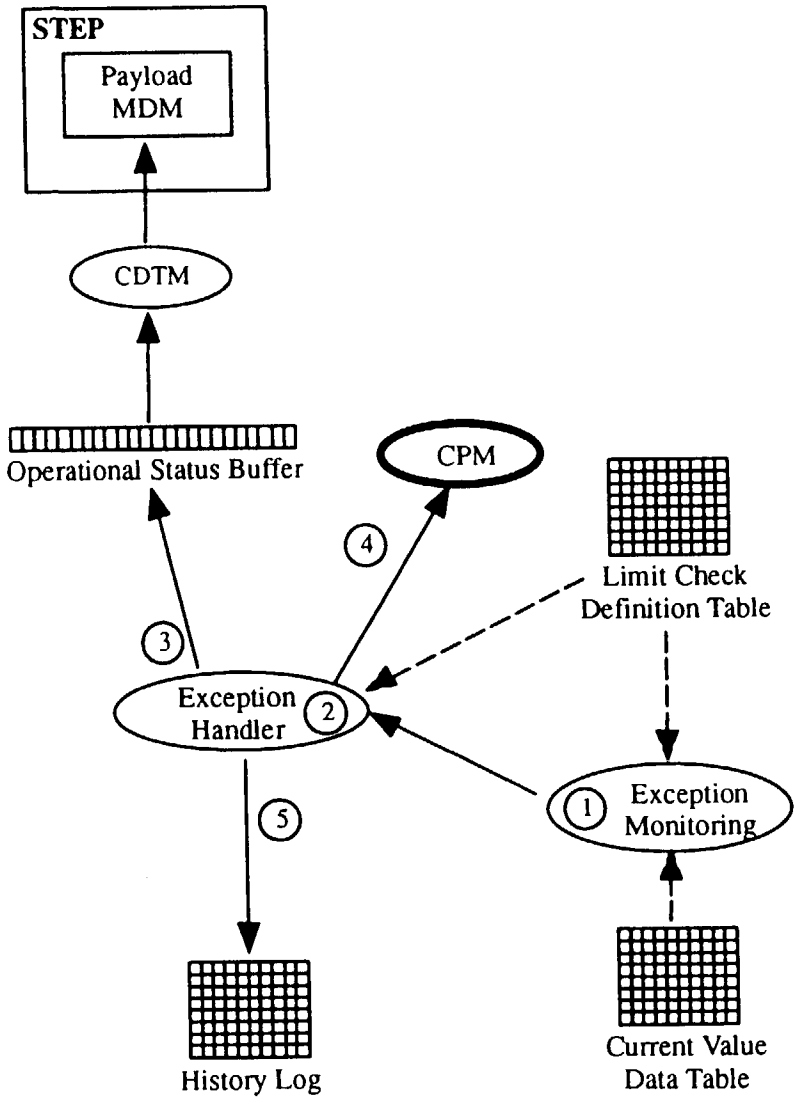
Ancillary Data Service Data Flow



1. The identifier associated with the incoming request indicates that the command is either a Start or Stop Ancillary Data Service Request. The parameters associated with the request identify the ancillary data set that is requested, indicate the target payload, and indicate whether the set is to be provided cyclically or aperiodically as a one–shot delivery.
2. The Ancillary Data Service (ADS) utilizes the Ancillary Data Definition Table (ADDT), the PL Configuration Data Table (PCDT), and the Service Status to determine if the requested data set is valid. The ADDT also specifies the rate at which the requested data set is to be delivered. The data addresses will point to the memory location within the Current Value Data Table (CVDT) where the requested data is actually stored. If the data set is determined to be invalid, then a command response is generated indicating that an invalid ancillary data set has been requested.
3. If the data set is determined to be valid, then the ADS will place the command in the Ancillary Data Request Queue.
4. The ADS pops the command off the Ancillary Data Request Queue and passes the command to the PL Interface Software (PIFS) to start/stop providing the ancillary data sets as appropriate.
5. The addresses of the requested ancillary data set is stored in the ADDT. PIFS will copy the data based on the addresses from the CVDT.
6. The Service Status is updated to show that the ancillary data set has been provided/terminated as appropriate.

EXPRESS Pallet Application Software

Exception Monitoring Service Data Flow



1. The monitoring function of the Exception Monitoring service will evaluate the enabled data items specified by the Limit Check Definition Table (LCDT). If a limit exception occurs, the alarm flag located in the appropriate table is checked to verify the limit has not been processed. If the alarm flag indicates that the exception has not been processed the limit exception will be handled by the exception handler. The alarm flag is reset when the value of the data item is within the specified exception range.

2. The Exception Handler performs the designated limit check definition data action. The possible actions for an exception are to initiate a command and provide notification to payload network laptops and C&W annunciations as appropriate or to send notification only.

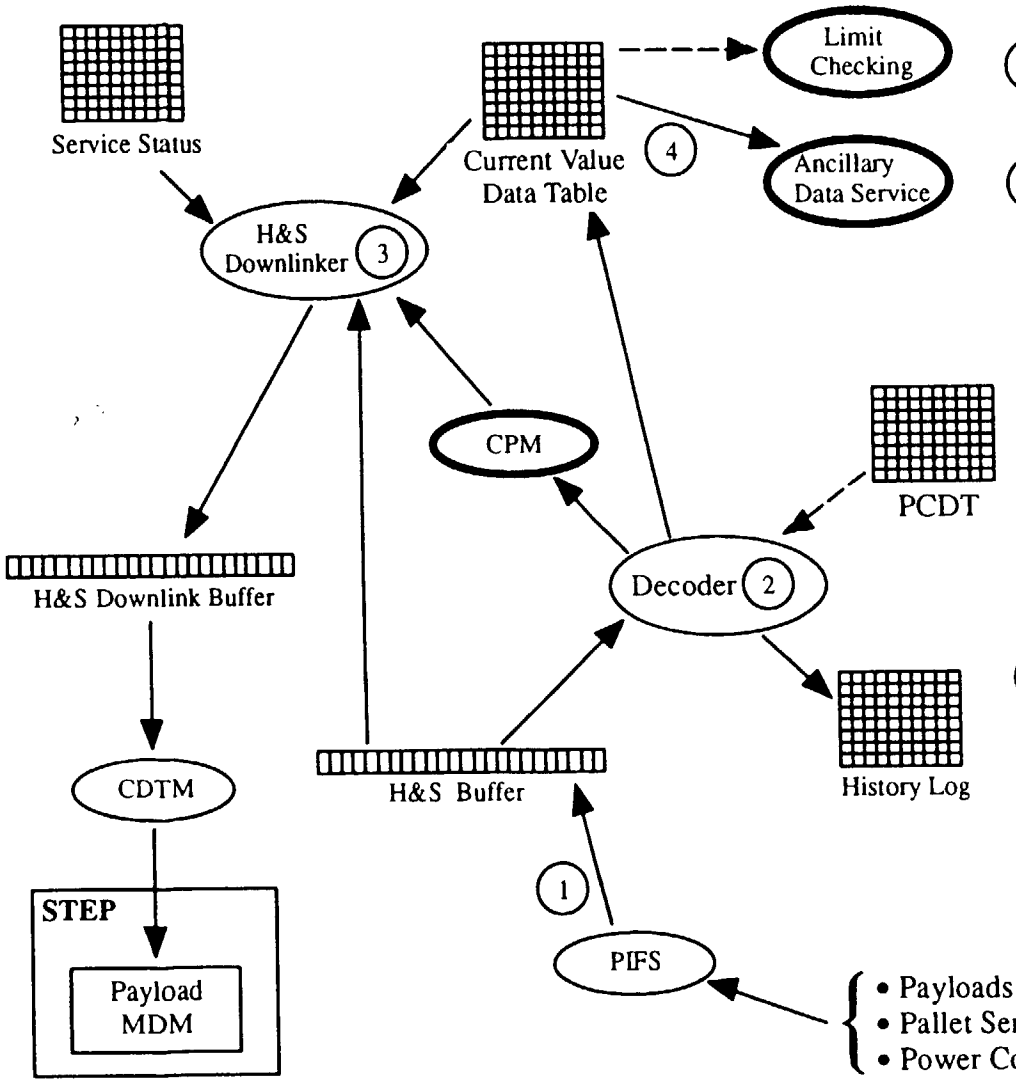
3. The C&C required C&W data will be provided to the C&C MDM (via the Payload MDM) via the Cyclic Data Transfer Mechanism (CDTM) as part of the Operational Status data. Notification will be sent to the payload local bus PCS via the Payload MDM. Note that C&C MDM, Payload MDM, and PCS functions are simulated in the STEP.

4. If the LCDT data indicated action/response is to initiate a command, the 64 word command is extracted from the LCDT. The command is then passed to the Command Processing Mechanism (CPM) for processing.

5. The history log will be updated with the Payload Index as applicable, data item addressing information, and the time of the limit exception event.

EXPRESS Pallet Application Software

Health & Status Service Data Flow



1. Collect data via the PL Interface Software (PIFS). The data collected is placed into the health & status buffer where it is available for decoding and downlinking.

2. The data in the health & status buffer is decoded into memory locations in the Current Value Data Table (CVDT). These memory locations are read from the portion of the Payload Configuration Data Table (PCDT) indexed by the payload providing the health and status subset ID and data. The data is then available for access by the limit checking and ancillary data services.

 The request data embedded in each payload's health & status data is read to determine if any payload is requesting services. If a service request is present, the Command Processing Mechanism (CPM) is sent the request data to be processed as a command.

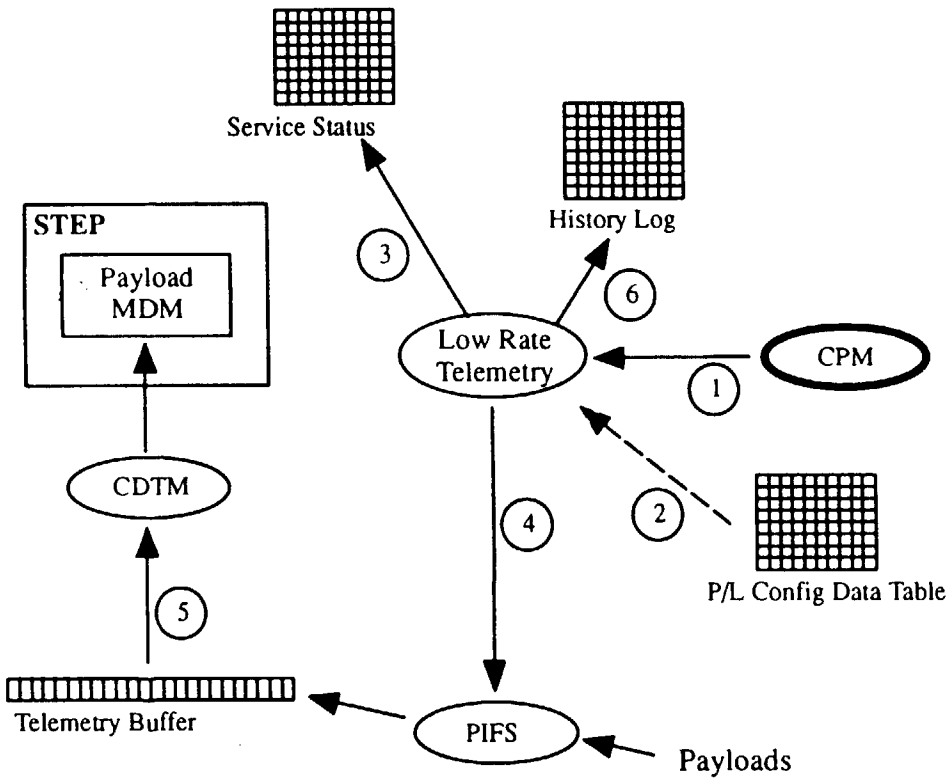
 If data is decoded from a payload configured to the Application Software as inactive then the anomaly is recorded in the history log. Conversely, if a payload configured as active fails to provide health & status it is also logged in the history log.

3. Once the health & status data from all payload systems has been collected, the health and status downlinker function then aggregates the EXPRESS Pallet unique data, payload health & status data, service log, history log, pallet sensor data, and power components data and places all the data into the health & status downlink buffer. The Cyclic Data Transfer Nechanism (CDTM) is then utilized to downlink the contents of the buffer at the prescribed rate.

4. The values of the payload, pallet sensor, and power component data items are available for limit checking and ancillary data services by direct addressing into the CVDT.

EXPRESS Pallet Application Software

Low Rate Telemetry Service Data Flow



1. Command Processing Mechanism (CPM) gets the command to start or stop low rate services from a payload's health & status data, C&C MDM and PCS via the Payload MDM, or from a script. CPM validates the command and sends command responses to the requesting source indicating the validity of the command. CPM ensures that the request is valid by verifying the Payload Index. If the request is not valid, then the request is recorded in the history log. If the request is valid, the services is started/stopped. Note that C&C MDM, Payload MDM, and PCS functions are simulated in the STEP.

2. The low rate telemetry service gets the appropriate addressing information and the rate information from the Payload Configuration Data Table (PCDT).

3. The low rate telemetry service updates the service status to reflect the low rate telemetry activity. If the command is to stop low rate telemetry service for a payload, the service status is updated to reflect that this service is not active for the component and the low rate telemetry service ceases expecting data from the payload.

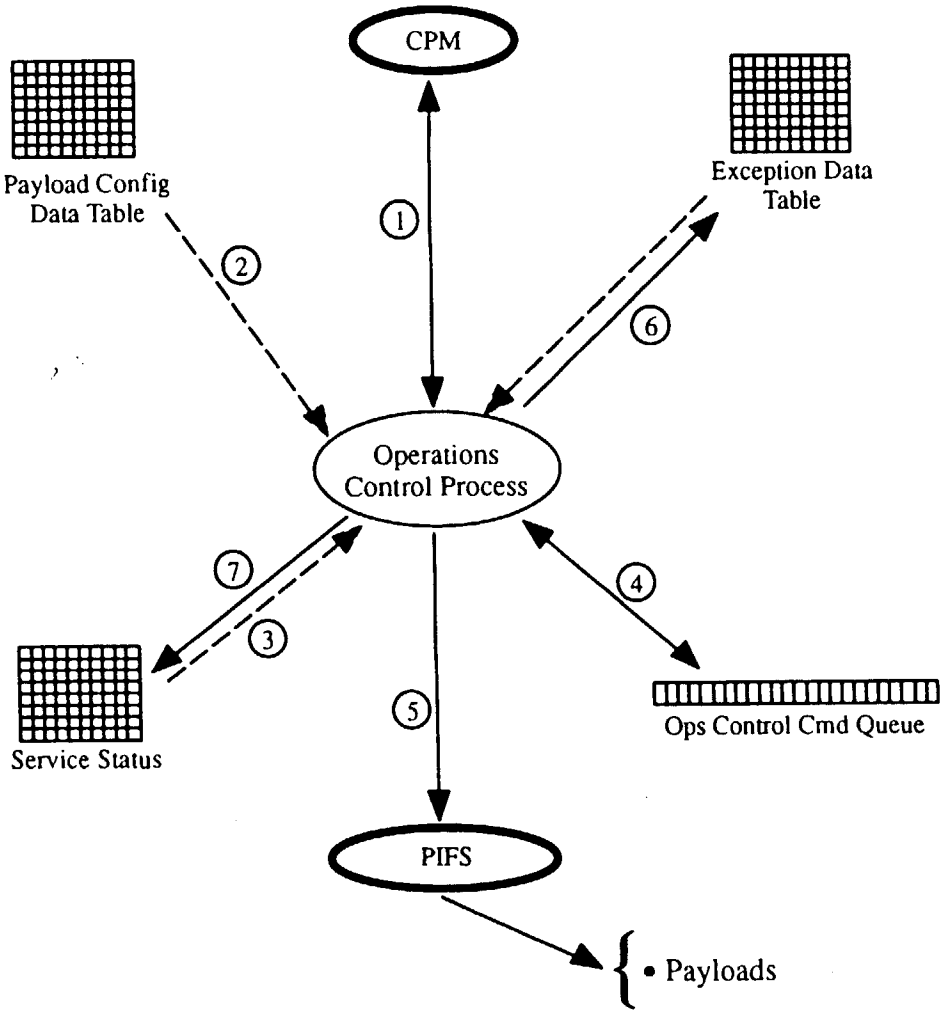
4. The Payload Interface Software PIFS gathers the data at the specified rate.

5. A payload's low rate telemetry data is packaged along with low rate telemetry data from other payloads and telemetered to the ground via the telemetry buffer and the Payload MDM.

6. The CPM will update the history log with a description of the transaction.

EXPRESS Pallet Application Software

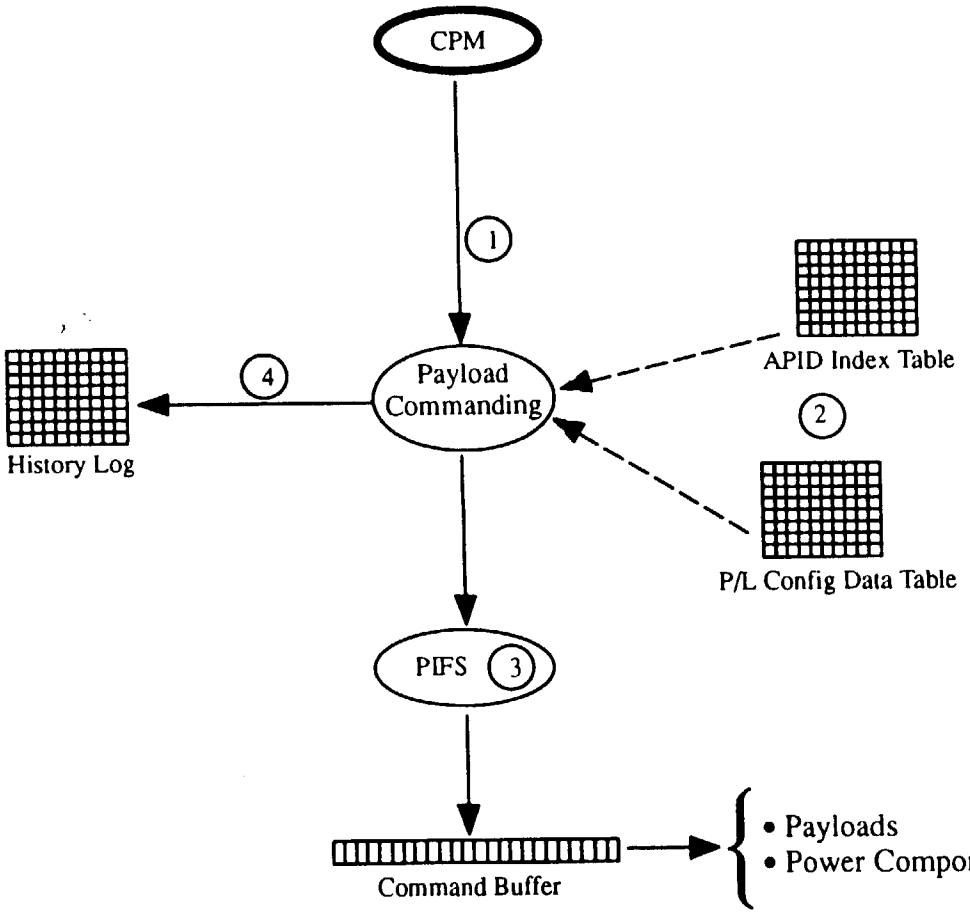
Operational Control Service Data Flow



1. The identification associated with the incoming request indicates that the command is a Power OFF Command. The parameters associated with the command indicate the which power channel to terminate.
2. The Operations Control Process (OPC) utilizes the Payload Configuration Data Table (PCDT) to determine which payloads are believed to draw from the power cable.
3. The Service Status is then checked for each payload identified as being attached to the power cable to determine if the payload is active. If no payloads are recognized to be active, an error code is generated and sent to the CPM indicating that there are no active payloads.
4. If it is determined that one or more payloads are active, the OCP will place the command in the Ops Control Command Queue.
5. The OCP will terminate Low Rate Telemetry and Ancillary Data Services and script execution if they are being provided to the payload(s) by calling PIFS with the appropriate parameters.
6. Limit Exception Services related to the payload(s) will be terminated by checking to see if the payload index is associated with any element(s) of the Exception Data Table. If so, the OCP will update the enable monitor such that the element is no longer monitored.
7. The OCP updates the Service Status to reflect that the affected payload(s) are now inactive, the power has been terminated, and that low rate telemetry, ancillary data, procedure execution services have been terminated.

EXPRESS Pallet Application Software

Payload Commanding Service Data Flow



1. The command packet originates via ground personnel, crew (PCS), or through scripting. Command Processing Mechanism (CPM) will update the payload command queue with the command packet and the Payload Commanding Service is activated to deliver the command. CPM will provide command responses indicating the validity of the commands via the Cyclic Data Transfer Mechanism (CDTM) or PCS interface. Any payload specific command validation will be routed through nominal cyclic payload status. Note that PCS functions are simulated in the STEP.

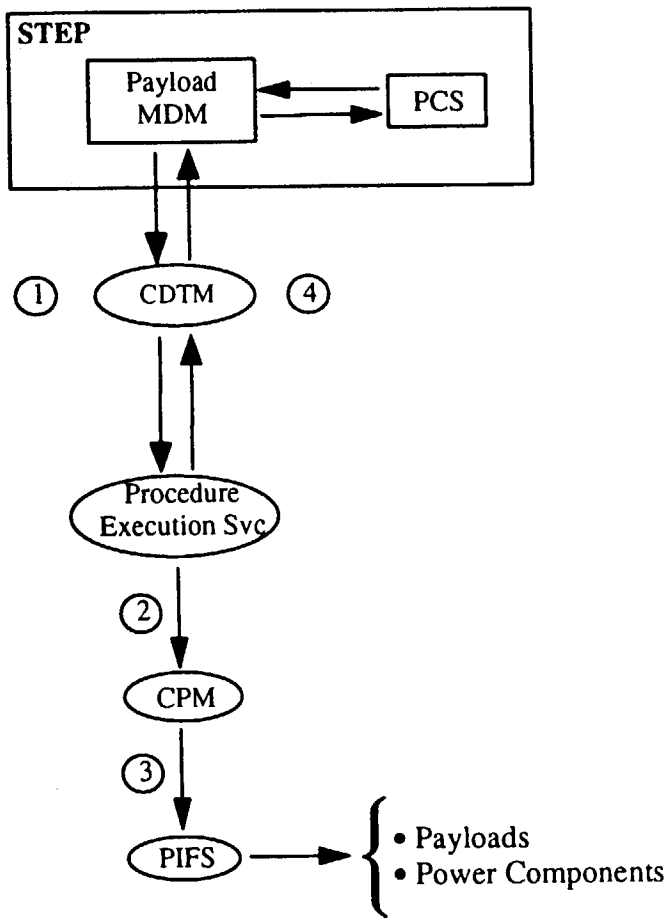
2. The Application Process Idenfication (APID) is then utilized to search the APID Index Table (AIT). The AIT associates all assigned and configured payload APIDs to a Payload Index. Once the AIT is searched and the APID located the Payload Index associated with the APID is utilized to read the Payload Configuration Data Table (PCDT).

3. The command packet is sent to the payload or the power components via the Payload Interface Software PIFS by utilizing the command buffer.

4. The results of command processing will be recorded in the history log. The data will include a unique identifier for the command, an ID of the destined payload or power component, current time, and any error status.

EXPRESS Pallet Application Software

Procedure Execution Service Data Flow



(1) The Procedure Execution Service Command Validation will determine the validity of the process request (resume, start, stop). The request is generated at a PCS. Note that PCS functions are simulated in the STEP.

(2) If the request is valid, the Procedure Execution Service will route the command to the Command Processing Mechanism (CPM) for processing.

(3) The command packet is sent to the payload or the power components via the Payload Interface Software (PIFS).

(4) In either case, an error code indicating the success/failure of the request is returned to the originator of the request.

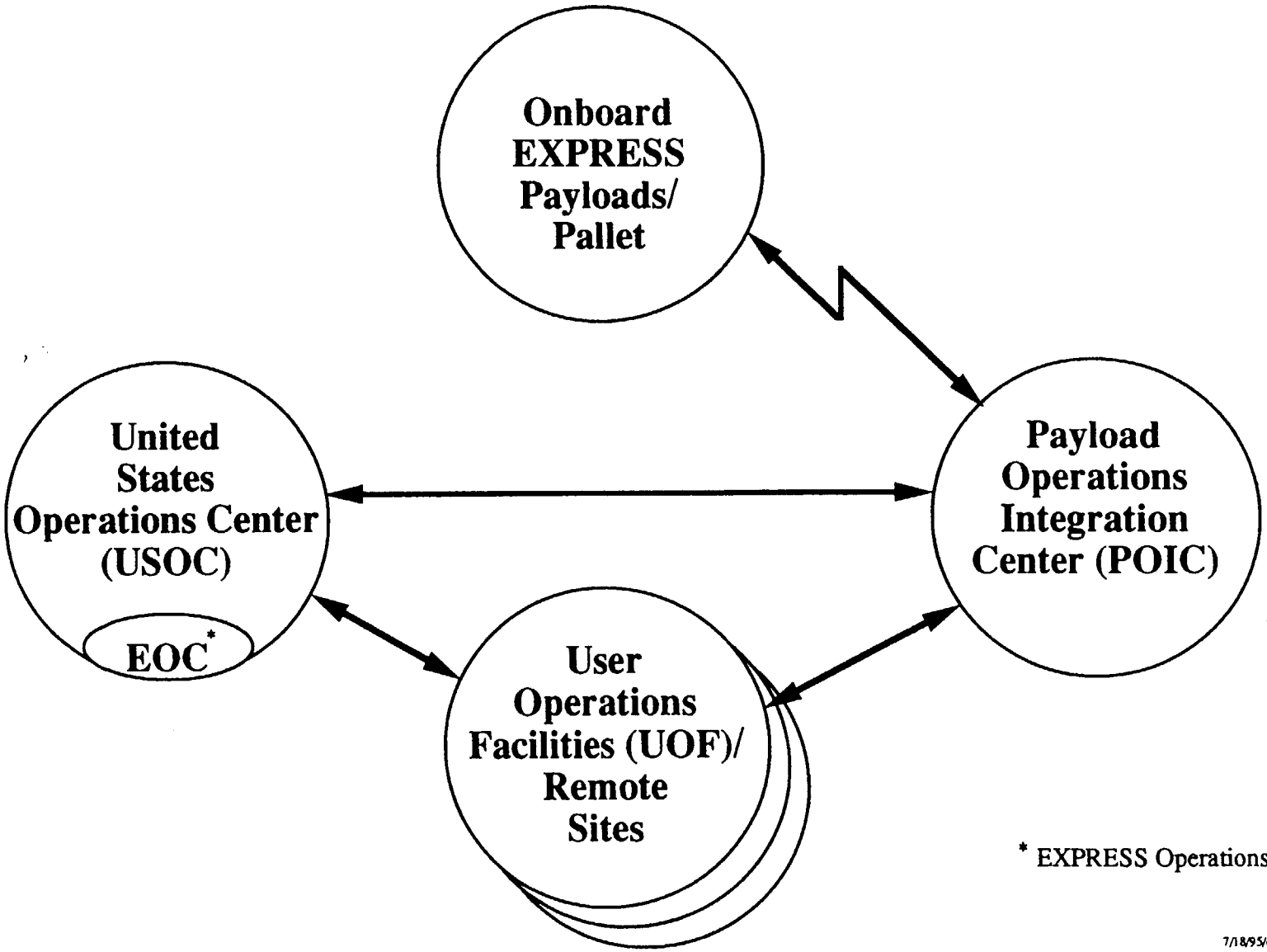




Section IX
Operations

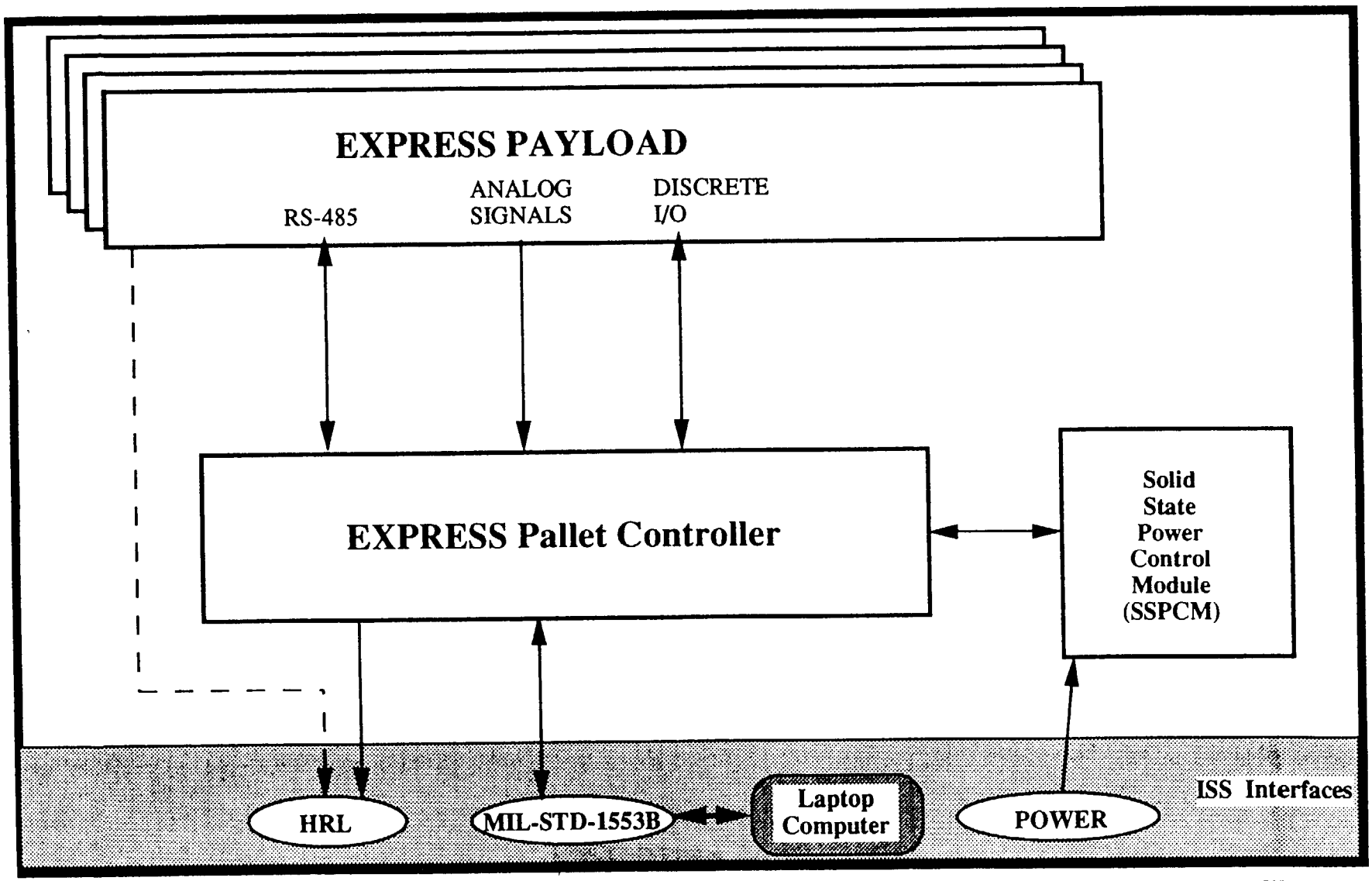
EXPRESS Pallet
Ground Demonstration Baseline Design Review

EXPRESS Pallet Operations Concept Overview



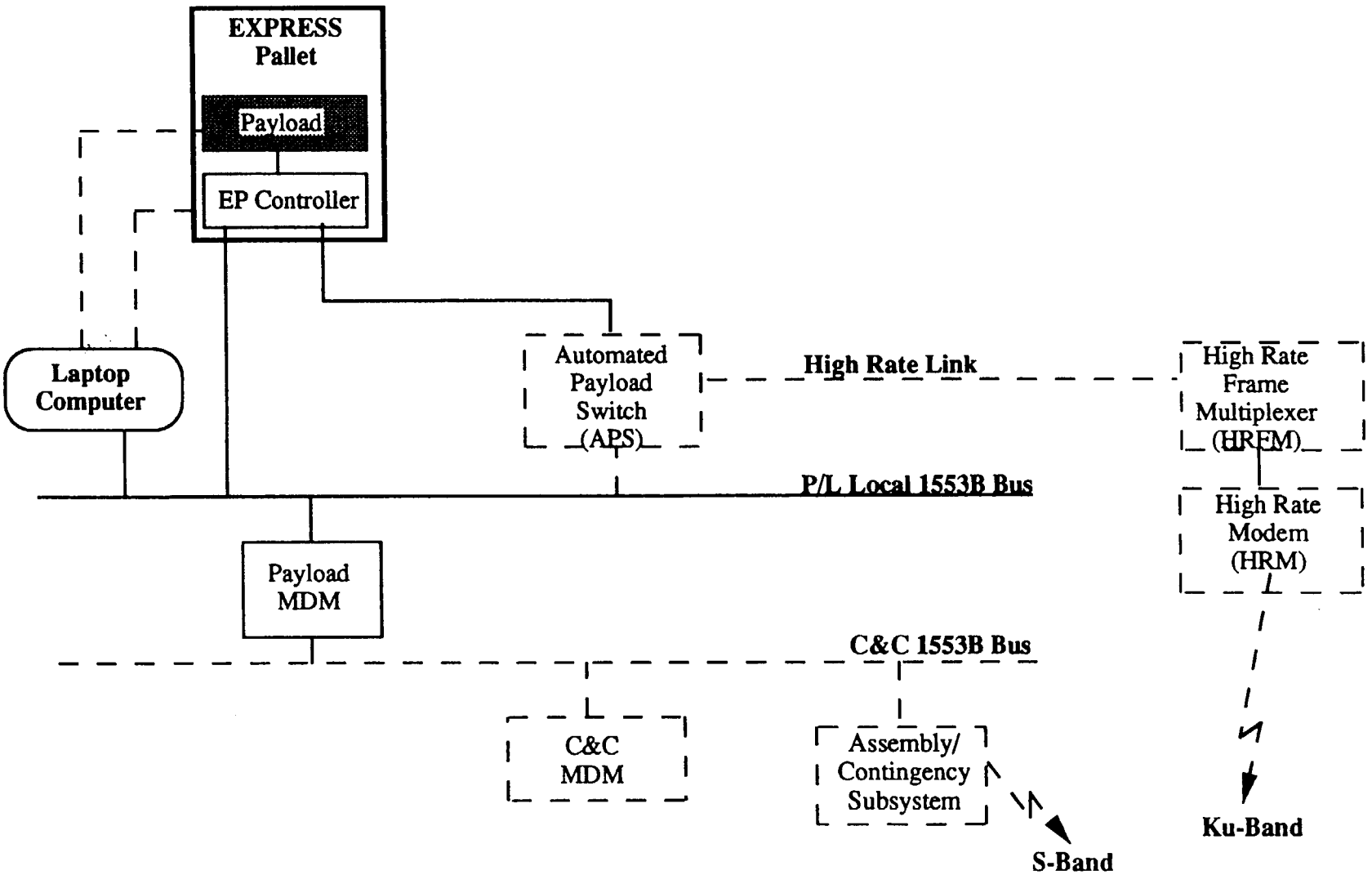
* EXPRESS Operations Controller

EXPRESS Pallet Operations Concept
Onboard EXPRESS Pallet Interfaces



7/18/95/crysel/EXPRESS Operations Concept

EXPRESS Pallet Operations Concept
Onboard Data Flow





EXPRESS Pallet Operations Concept
User Payload Commanding Provisions



- Portable Computer System (PCS)
 - Crew access to Onboard Short-Term Plan, procedures, commanding and displays
 - Interfaces to C&DH System
 - MIL-STD-1553B or Ethernet Interface
 - Command EXPRESS Pallet Controller and payloads directly
 - Displays EXPRESS Pallet Controller, Payload MDM and payload Health and Status

- Ground Commanding
 - Remote sites
 - User Operations Facility (UOF)
 - United States Operations Center (USOC)
 - POIC





Section X
KSC Integration and Operations

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Chuong Nguyen

Agenda

- KSC Integration and Operations -

EXPRESS Pallet Ground Demonstration Baseline Design Review

INTERNATIONAL SPACE STATION ALPHA

- Background
- Processing
- Attached Payload Equipment
- Facility Layout and Characteristics
- Payload Test & Checkout



Background

- KSC Integration and Operations -

EXPRESS Pallet Ground Demonstration Baseline Design Review

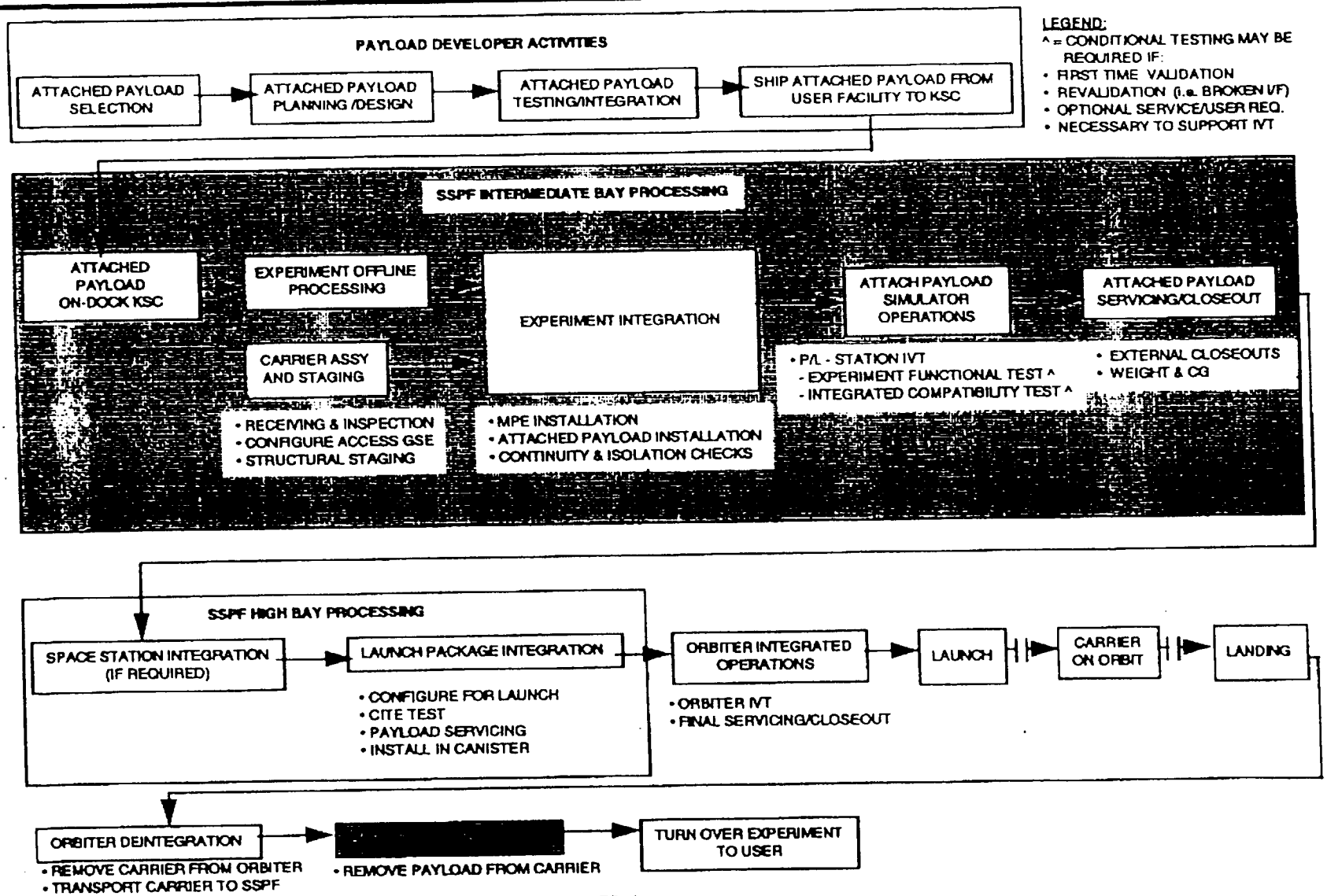


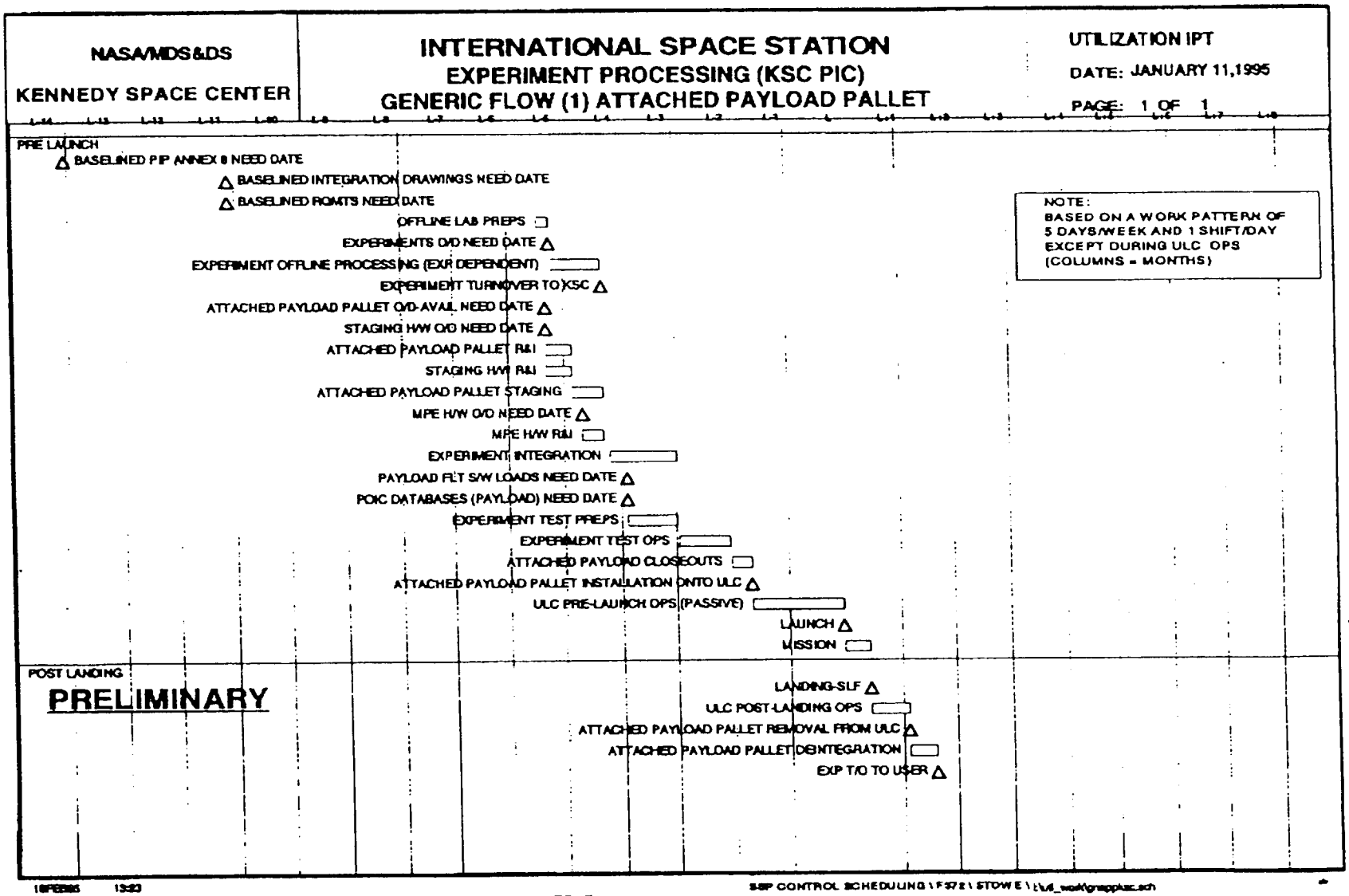
- **According to the ISS Technical Task Agreement(TTA) between KSC and the Utilization IPT, KSC is to provide the capability for the physical integration, interface verification and post flight support of attached payloads. In addition, KSC is to provide mission direct support for flight hardware processing pre/post flight.**
- **KSC Utilization Roles**
 - **Provide Off-line Lab (OLL) space and necessary logistics in support of the physical integration and checkout of Attached Payloads.**
 - **Provide personnel to support Attached Payload OLL activities as required.**
 - **Provide all facilities, personnel and procedures required for the physical integration and checkout of payload/carrier to EXPRESS pallet. Post flight deintegration of payload/adapter from EXPRESS pallet is also performed by KSC.**

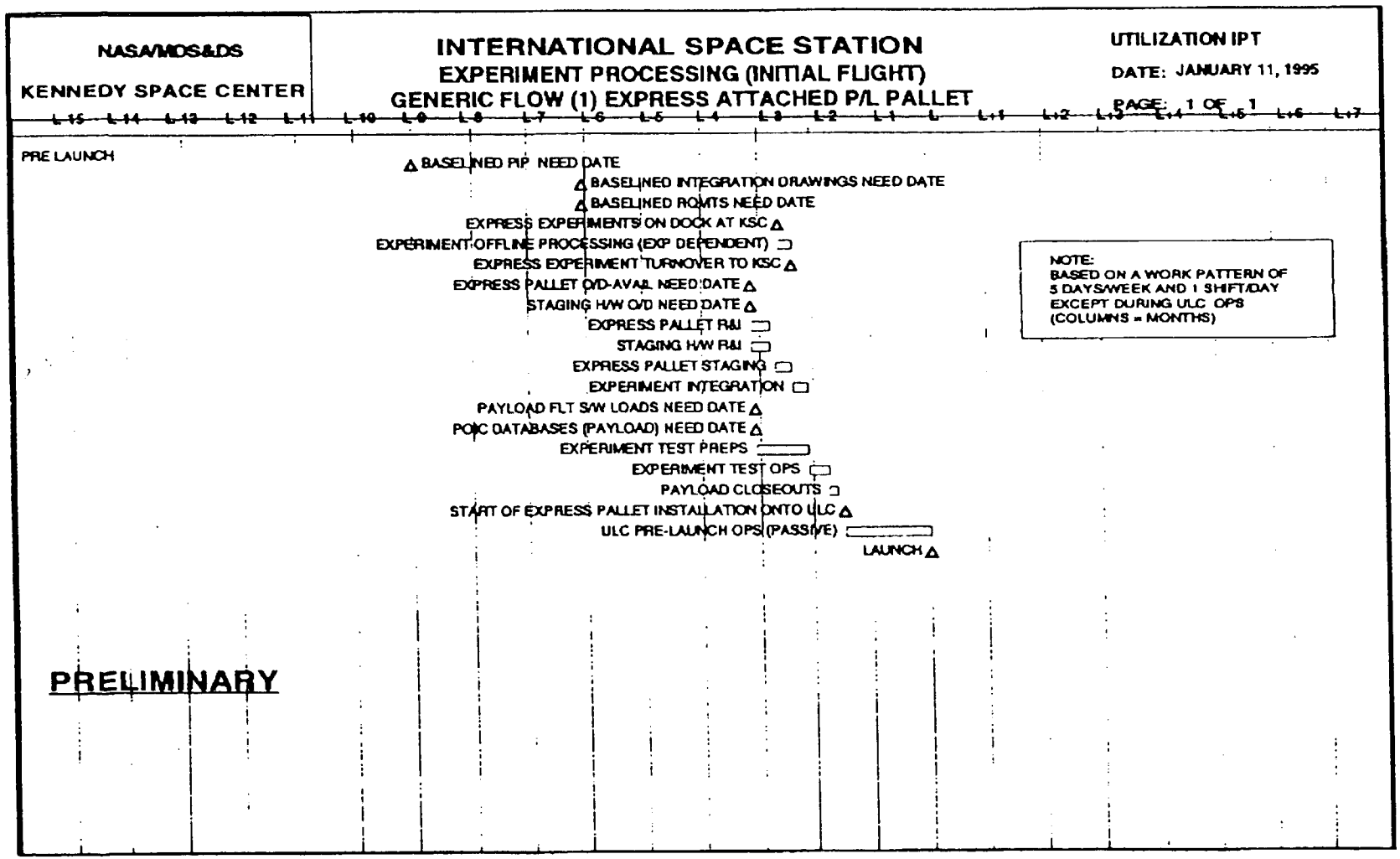
SPACE STATION UTILIZATION
ATTACHED PAYLOAD PROCESSING

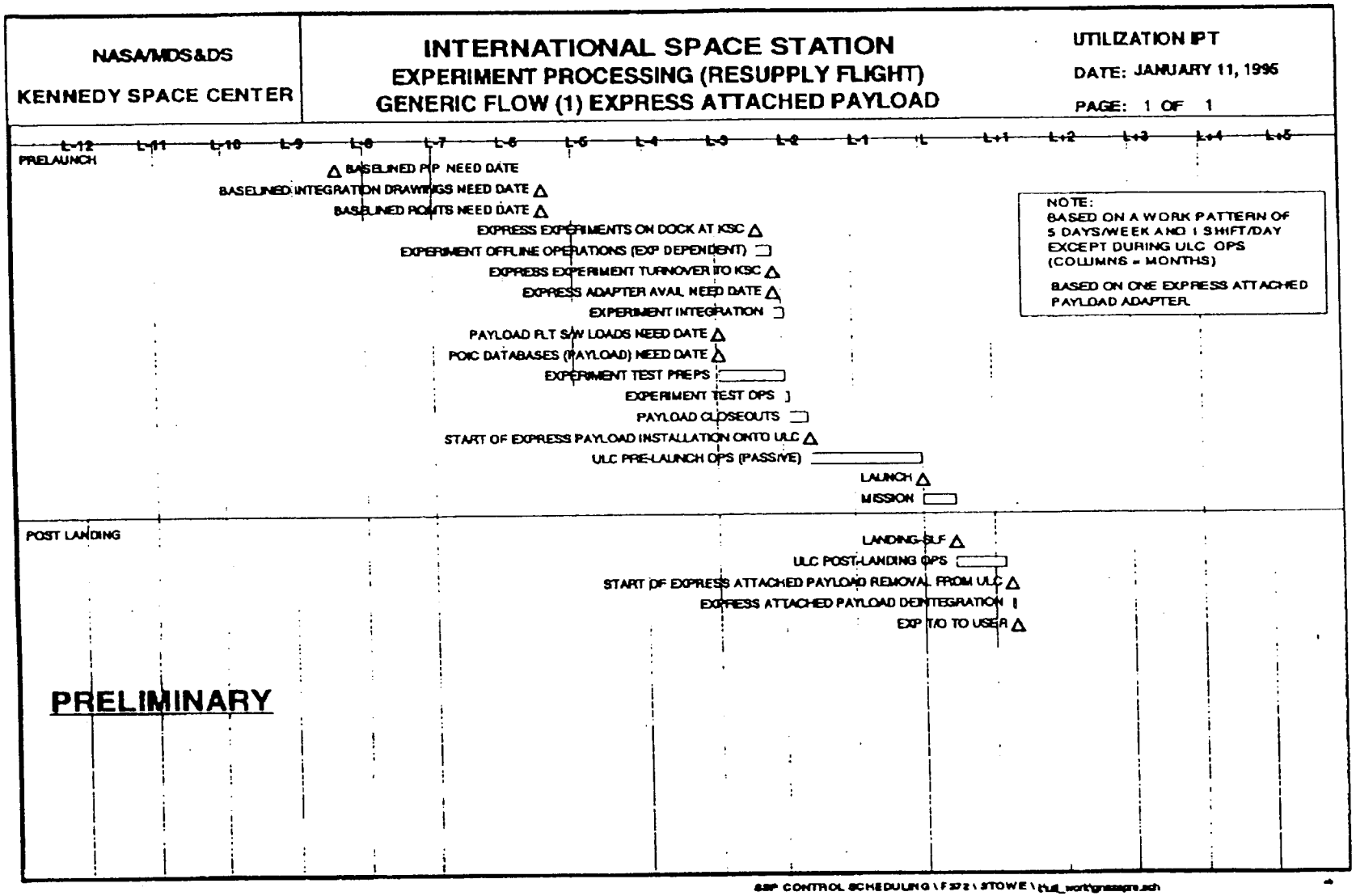
- KSC Integration and Operations -
EXPRESS Pallet Ground Demonstration Baseline Design Review

INTERNATIONAL SPACE STATION ALPHA




NASA/MDS&DS
KENNEDY SPACE CENTER
INTERNATIONAL SPACE STATION
EXPERIMENT PROCESSING (KSC PIC)
GENERIC FLOW (1) ATTACHED PAYLOAD PALLET
UTILIZATION IPT
DATE: JANUARY 11,1995
PAGE: 1 OF 1
PRE LAUNCH
BASELINED PIP ANNEX 8 NEED DATE
BASELINED INTEGRATION DRAWINGS NEED DATE
BASELINED ROMTS NEED DATE
OFFLINE LAB PREPS
EXPERIMENTS O/D NEED DATE
EXPERIMENT OFFLINE PROCESSING (EXP DEPENDENT)
EXPERIMENT TURNOVER TO KSC
ATTACHED PAYLOAD PALLET O/D-AVAIL NEED DATE
STAGING H/W O/D NEED DATE
ATTACHED PAYLOAD PALLET R&I
STAGING H/W R&I
ATTACHED PAYLOAD PALLET STAGING
MPE H/W O/D NEED DATE
MPE H/W R&I
EXPERIMENT INTEGRATION
PAYLOAD FLT S/W LOADS NEED DATE
POIC DATABASES (PAYLOAD) NEED DATE
EXPERIMENT TEST PREPS
EXPERIMENT TEST OPS
ATTACHED PAYLOAD CLOSEOUTS
ATTACHED PAYLOAD PALLET INSTALLATION ONTO ULC
ULC PRE-LAUNCH OPS (PASSIVE)
LAUNCH
MISSION
NOTE:
BASED ON A WORK PATTERN OF
5 DAYS/WEEK AND 1 SHIFT/DAY
EXCEPT DURING ULC OPS
(COLUMNS = MONTHS)
POST LANDING
PRELIMINARY
LANDING-SLF
ULC POST-LANDING OPS
ATTACHED PAYLOAD PALLET REMOVAL FROM ULC
ATTACHED PAYLOAD PALLET DISINTEGRATION
EXP T/O TO USER


NASA/MDSS&DS
KENNEDY SPACE CENTER
INTERNATIONAL SPACE STATION
EXPERIMENT PROCESSING (INITIAL FLIGHT)
GENERIC FLOW (1) EXPRESS ATTACHED P/L PALLET
UTILIZATION IPT
DATE: JANUARY 11, 1995
PAGE: 1 OF 1
L-15 L-14 L-13 L-12 L-11 L-10 L-9 L-8 L-7 L-6 L-5 L-4 L-3 L-2 L-1 L L+1 L+2 L+3 L+4 L+5 L+6 L+7
PRE LAUNCH
BASELINED PIP NEED DATE
BASELINED INTEGRATION DRAWINGS NEED DATE
BASELINED RQMTS NEED DATE
EXPRESS EXPERIMENTS ON DOCK AT KSC
EXPERIMENT OFFLINE PROCESSING (EXP DEPENDENT)
EXPRESS EXPERIMENT TURNOVER TO KSC
EXPRESS PALLET O/D-AVAIL NEED DATE
STAGING H/W O/D NEED DATE
EXPRESS PALLET R&I
STAGING H/W R&I
EXPRESS PALLET STAGING
EXPERIMENT INTEGRATION
PAYLOAD FLT S/W LOADS NEED DATE
POIC DATABASES (PAYLOAD) NEED DATE
EXPERIMENT TEST PREPS
EXPERIMENT TEST OPS
PAYLOAD CLOSEOUTS
START OF EXPRESS PALLET INSTALLATION ONTO ULC
ULC PRE-LAUNCH OPS (PASSIVE)
LAUNCH
NOTE:
BASED ON A WORK PATTERN OF
5 DAYS/WEEK AND 1 SHIFT/DAY
EXCEPT DURING ULC OPS
(COLUMNS = MONTHS)
PRELIMINARY


NASA/MDS&DS
KENNEDY SPACE CENTER
INTERNATIONAL SPACE STATION
EXPERIMENT PROCESSING (RESUPPLY FLIGHT)
GENERIC FLOW (1) EXPRESS ATTACHED PAYLOAD
UTILIZATION IPT
DATE: JANUARY 11, 1995
PAGE: 1 OF 1
L-12 L-11 L-10 L-9 L-8 L-7 L-6 L-5 L-4 L-3 L-2 L-1 L L+1 L+2 L+3 L+4 L+5
PRELAUNCH
BASELINED PIP NEED DATE
BASELINED INTEGRATION DRAWINGS NEED DATE
BASELINED POINTS NEED DATE
EXPRESS EXPERIMENTS ON DOCK AT KSC
EXPERIMENT OFFLINE OPERATIONS (EXP DEPENDENT)
EXPRESS EXPERIMENT TURNOVER TO KSC
EXPRESS ADAPTER AVAIL NEED DATE
EXPERIMENT INTEGRATION
PAYLOAD FLT S/W LOADS NEED DATE
POIC DATABASES (PAYLOAD) NEED DATE
EXPERIMENT TEST PREPS
EXPERIMENT TEST OPS
PAYLOAD CLOSEOUTS
START OF EXPRESS PAYLOAD INSTALLATION ONTO ULC
ULC PRE-LAUNCH OPS (PASSIVE)
LAUNCH
MISSION
NOTE:
BASED ON A WORK PATTERN OF 5 DAYS/WEEK AND 1 SHIFT/DAY EXCEPT DURING ULC OPS (COLUMNS = MONTHS)
BASED ON ONE EXPRESS ATTACHED PAYLOAD ADAPTER
POST LANDING
LANDING-SLF
ULC POST-LANDING OPS
START OF EXPRESS ATTACHED PAYLOAD REMOVAL FROM ULC
EXPRESS ATTACHED PAYLOAD DEINTEGRATION
EXP T/O TO USER
PRELIMINARY
SSP CONTROL SCHEDULING \ F372 \ STOWE \

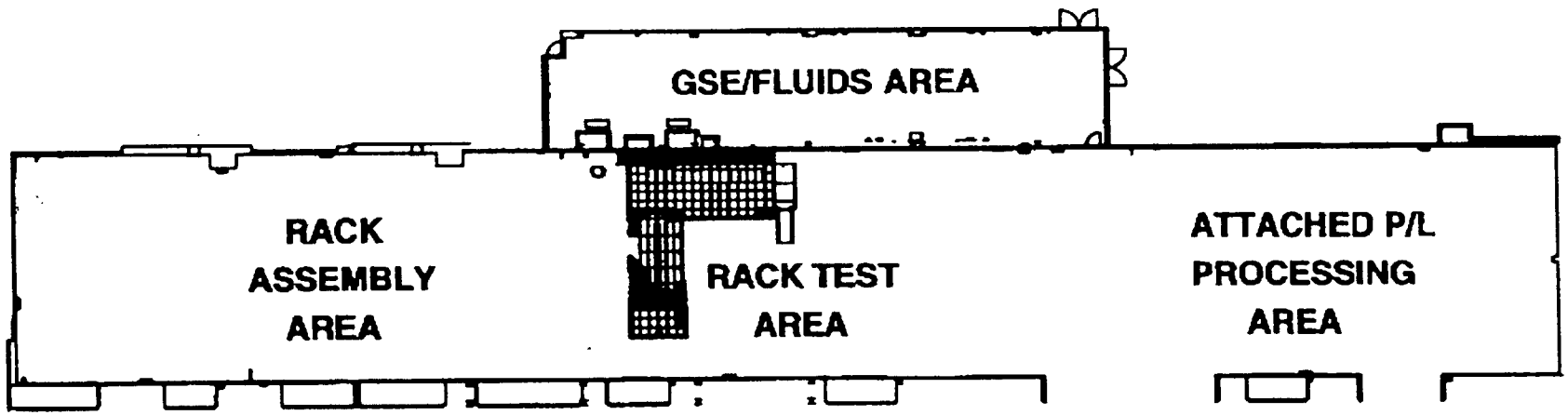
- **Equipment needed for Attached Payload integration & checkout at the launch site have been identified and included in budget submissions.**
- **Program Provided**
 - **Truss berthing port I/F simulator with the following elements**
 - » **Active UMA simulator**
 - » **UMA simulator harness set**
 - » **Capture latch simulator**
 - » **Truss berthing port I/F structure**
 - **C&DH and C&T FEU's**
 - **EXPRESS Pallet Simulator**
- **KSC Developed**
 - **Support Stands**
 - **Slings**
 - **Cables**

- **SSPF**
 - **This facility provides for the controlled assembly, test, servicing, and post-flight activities/support associated with all assembly, utilization, and resupply flights. The following facilities are of particular interest to the User.**
- **SSPF Off-line Laboratories**
 - **These labs can provide for the user standard lab gases, and vents support, network, comm, and TCMS support, potable water, and hard point access for lifting. Specialized labs provide chemical and dark room lab support. All services are not common to each lab.**
- **Intermediate Bay (I-Bay)**
 - **This large area was designed to accommodate both rack (ISPR and Stowage) and Attached Payload processing. Facility services (power, gases, and data drops) are distributed throughout this area to maximize the flexibility and adapt to a variety of payload configurations. The ISPR checkout system (USICU) and Attached Payload Checkout Simulator are located in this area.**

SSPF INTERMEDIATE BAY

- KSC Integration and Operations -

EXPRESS Pallet Ground Demonstration Baseline Design Review



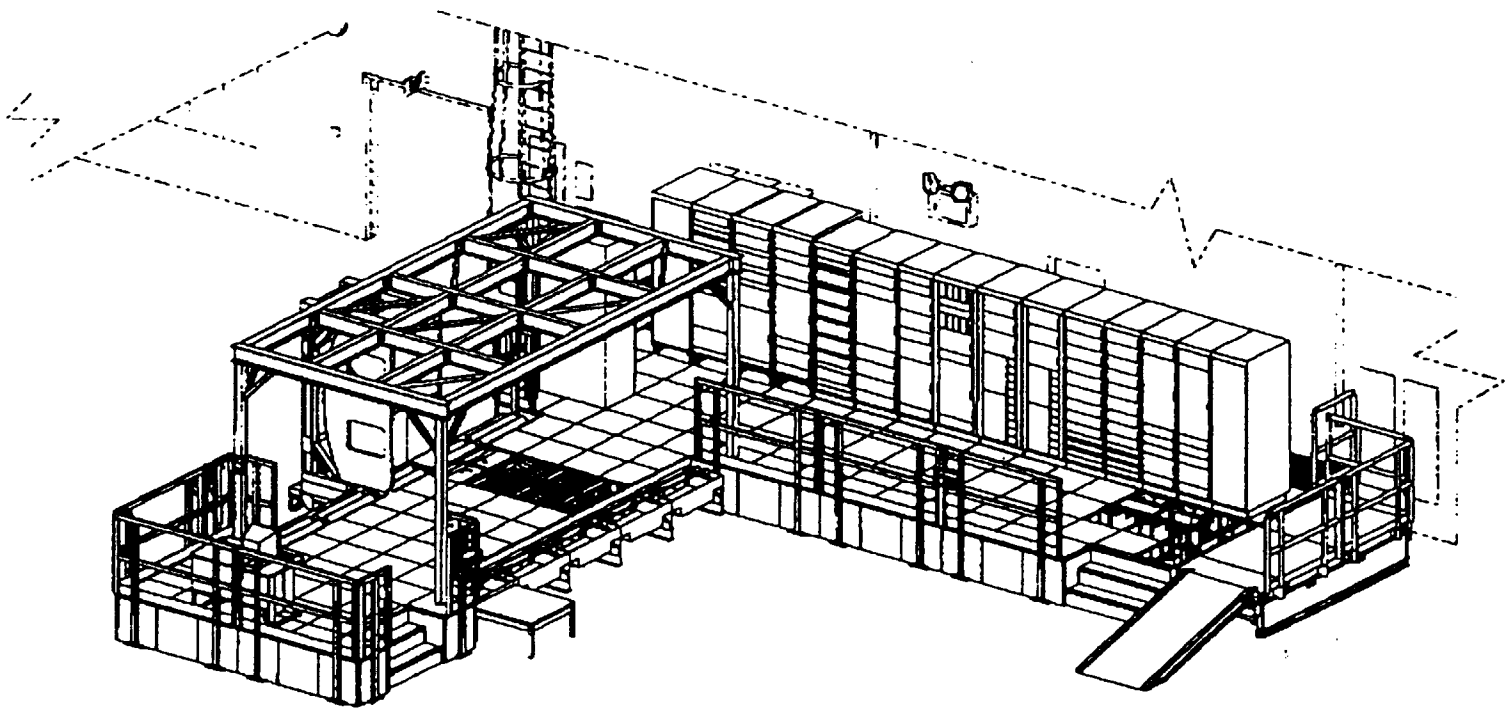
EXPERIMENT CHECKOUT SUBSYSTEMS

- KSC Integration and Operations -

EXPRESS Pallet Ground Demonstration Baseline Design Review

INTERNATIONAL SPACE STATION ALPHA

- US ISPR CHECKOUT UNIT (USICU)
 - Gaseous Nitrogen (GN2)
 - Vacuum Exhuast/Resources Systems (VES/VRS)
 - Thermal Control System (TCS)
 - Electrical Power System (EPS)
- TEST, CONTROL, AND MONITORING SYSTEM (TCMS)
- COMMUNICATION AND TRACKING (C&T)
- COMMAND AND DATA HANDLING (C&DH)
- PAYLOAD OPERATIONS INTEGRATION CENTER (POIC-KSC)
- INTERNATIONAL PARTNERS INTERFACE SIMULATION FOR US PAYLOAD TESTING
- ATTACHED PAYLOAD SIMULATOR



- **The USICU is being "Re-engineered" to meet the the Program's goal as a result of the Ship & Shoot, Short Cycle Action Team (SCAT), and the Utilization, Operations, and Training Assessment Team (UOTAT) studies**
- **The Attached Payload I/F Simulator is a Program provided capability integrated with the USICU subsystems to provide for payload to Station Interface Verification Testing.**

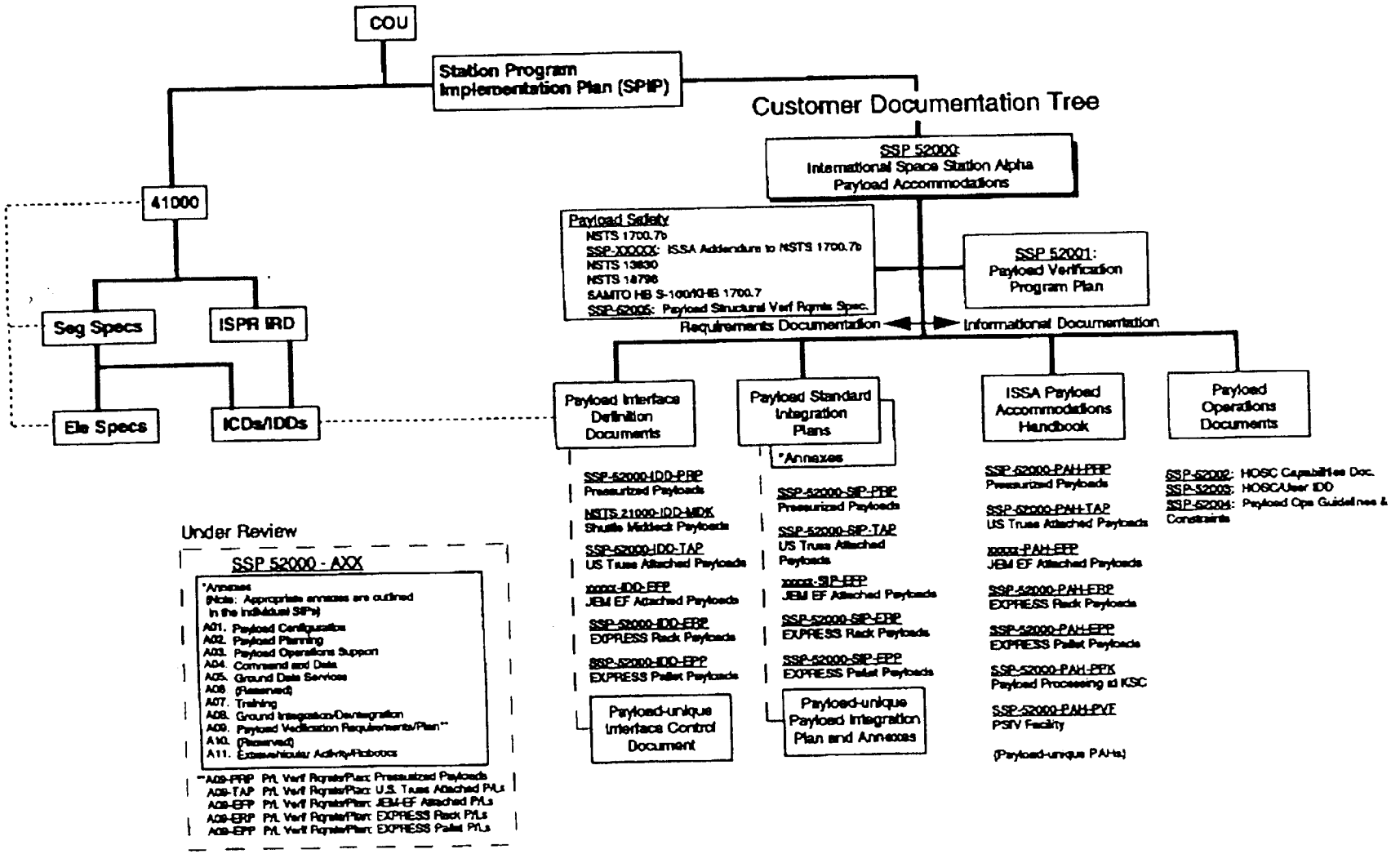
Section XI
Document Tree

EXPRESS Pallet
Ground Demonstration Baseline Design Review

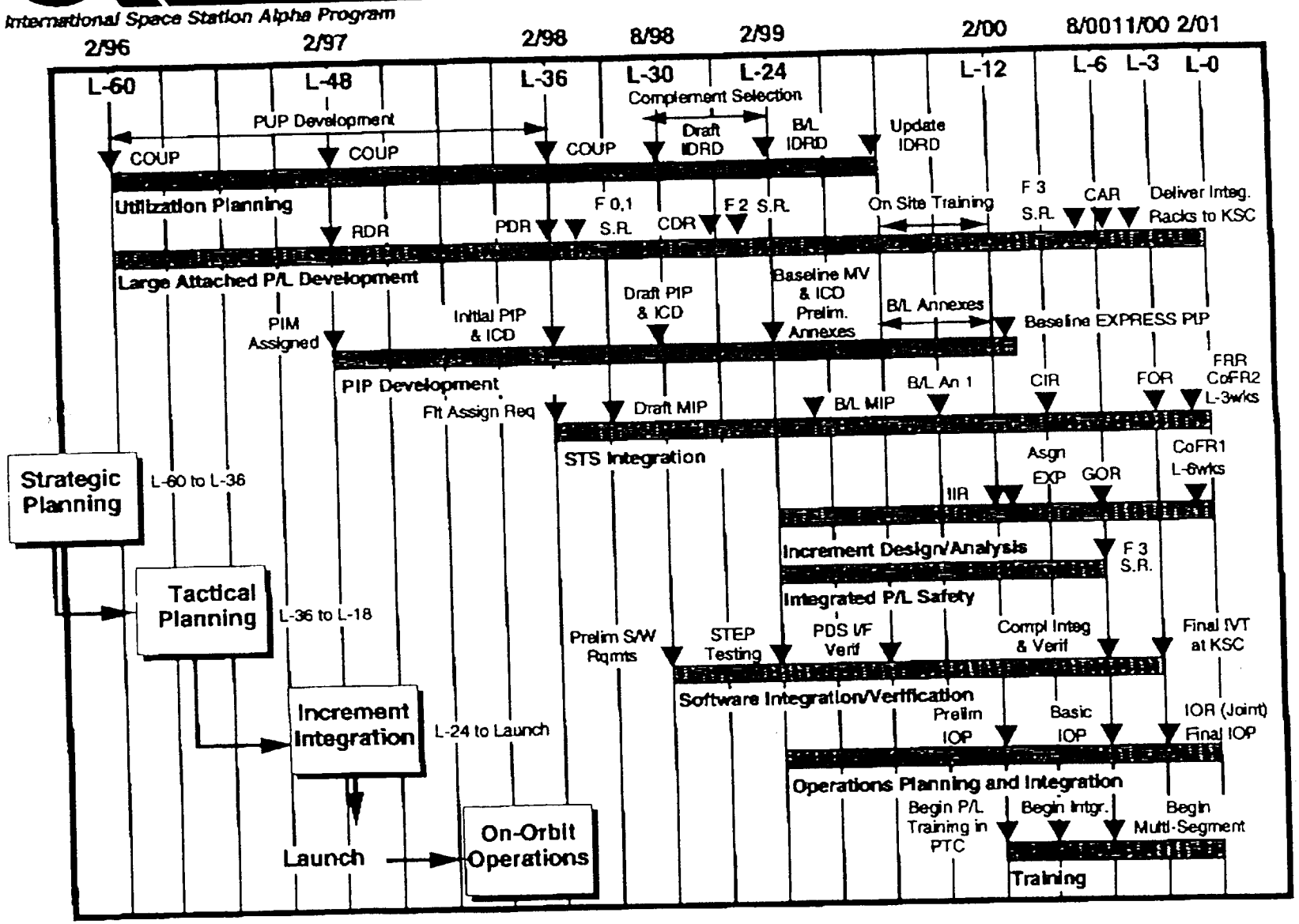
Jim Scheib

Customer Documentation Tree

International Space Station Alpha Program



UF-4 Increment Planning and Integration Template







Section XII
Payload Candidates

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Lowell Primm

EXPRESS Pallet Demonstration Payload Status

	Payload	Sponsor	HW Status	Experiment Fidelity	Rqmts.
1	Optical Properties Monitor Part #	Code X	N/A		
2	Hydrogen Maser Clock Part #	Code X	N/A		
3	Emulsion Chamber Tech. (ECT) Part #	Code X	?	Engr Model/Flight	TBD
4	Solar Array Module Plasma Interaction Exp (SAMPIE)	Code X	?	TBD	TBD
5	CONCAP	Code X	?	Engr Model/Flight	TBD
6	Hexapod Part #	European Space Agency (ESA)	TBD	Mockup	Preliminary
7	Blow Bubbles (GAS)	Utah State	Available	Downgraded Flight	N/A
8	Wide FOV Camera Part #	Code ?/MSFC	?	Flight	TBD
9	Optical Transient Det. (OTD) Part #	Code ?/MSFC	Available 4/95	Eng. Model	N/A
10	Exobiology Radiation App. (ERA) Part #	ESA	Available 8/95	Downgraded Flight	Preliminary
11	SAM II Part #	Code Y/LaRC	TBD	Eng. Model	TBD

INTERNATIONAL SPACE STATION ALPHA

EXPRESS Pallet Demonstration Payload Status

	Payload	Sponsor	HW Status	Experiment Fidelity	Rqmts.
12	SAGE III Part #	Code Y/LaRC	TBD	Eng. Model	PDR
13	ATMOS		?		
14	MAS		?		
15	ACRIM		?		
16					
17					
18					
19					
20					
21					
22					

WE NEED PAYLOADS NOW!





Section XIII
Thermal

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Darin Boyer



EXPRESS Pallet Design Review

Thermal Analysis

Darin S. Boyer
Thermal Analysis
(205) 461-3797

Agenda

- **Thermal Requirements**
- **Types of Thermal Analyses (*similarities to ULC*)**
 - **Optical Property Parametric Analysis**
 - **Shuttle Flight Analysis**
 - **On-Orbit Analyses**
 - **Element Level Analyses**

Thermal Requirements

- The *EXPRESS* Pallet must meet performance requirements when subjected to the following thermal environments.
 - Transportation
 - Storage
 - Prelaunch
 - Ascent
 - On-Orbit
 - Descent
 - Ferry Flight
 - Ground Contingency Site Hold

Touch Temperature Requirement

The *EXPRESS* Pallet must be maintained within the acceptable temperature range such that the minimum and maximum allowable EVA touch temperature limits are not exceeded.

Example...Unpressurized Logistics Carrier

- **The EVA touch temperature limits are based upon the maximum allowable heat flux between the ULC surfaces and a gloved hand considering incidental contact.**

 Parameters:

 1) Material of ULC is Aluminum

 2) Structure thickness is 0.25 inches

- **Based upon these parameters, the minimum and maximum EVA touch temperature limits are approximately...**

 Minimum: -215 °F

 Maximum: 246 °F

Thermal Models

- **Preliminary design thermal models will be developed to represent the *EXPRESS* Pallet configuration.**
 - **TRASYS and SINDA will be used to simulate thermal environments and predict structure temperatures.**

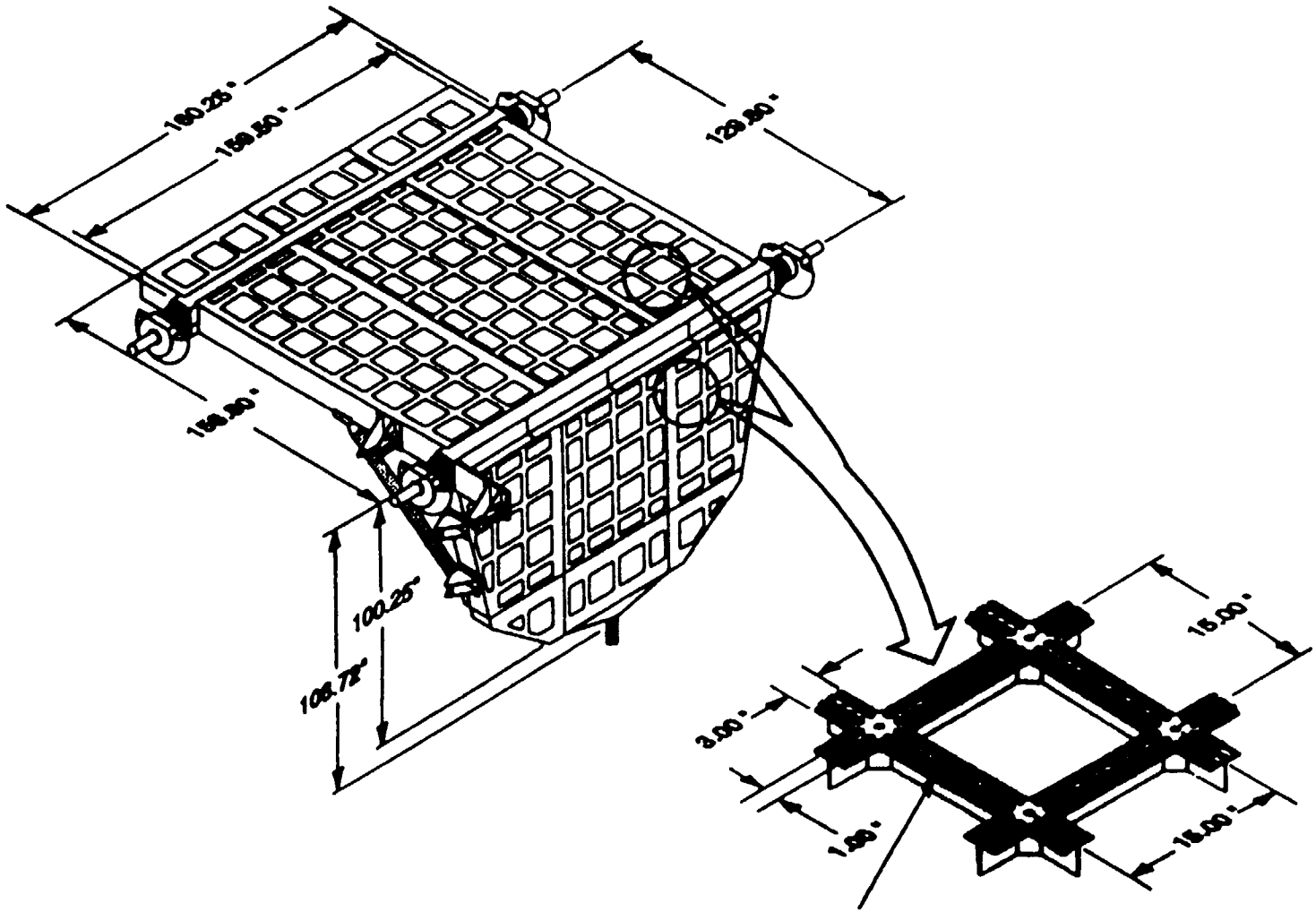
Optical Property Parametric Analysis

- **A thermal analysis will be performed to determine the minimum and maximum *EXPRESS* Pallet temperatures for a generic spread of optical properties.**
 - **This parametric study will determine the range of optical properties (α and ε) required to maintain the *EXPRESS* Pallet within the acceptable temperature range.**
 - **Select a material and surface coating that exhibits optical properties in desired range.**

EXPRESS Pallet Design Review
Thermal Analysis

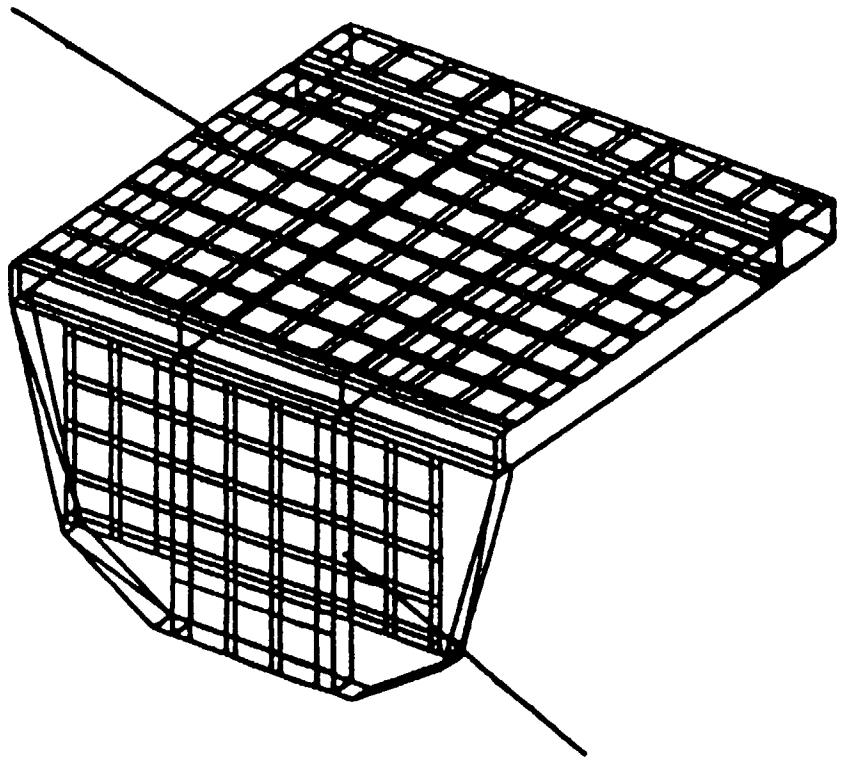
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ULC Configuration



ULC Thermal Model

Horizontal (Top) Deck



Vertical Deck

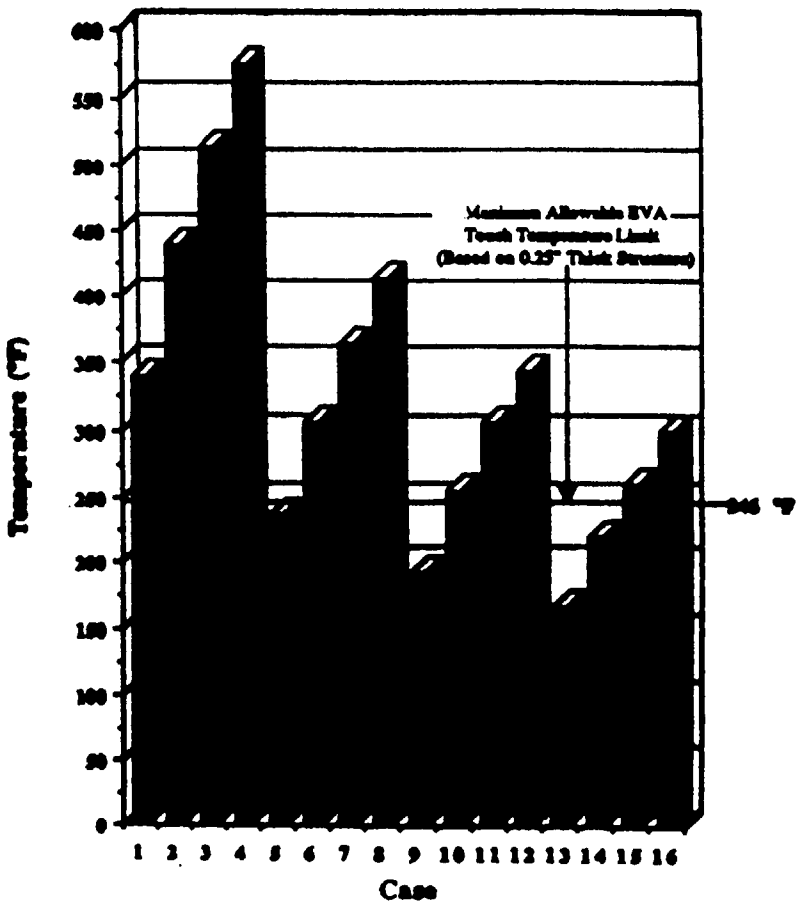
Generic Spread of Optical Properties for ULC

Solar Absorptivity: 0.2, 0.4, 0.6 and 0.8
Emissivity: 0.2, 0.4, 0.6 and 0.8

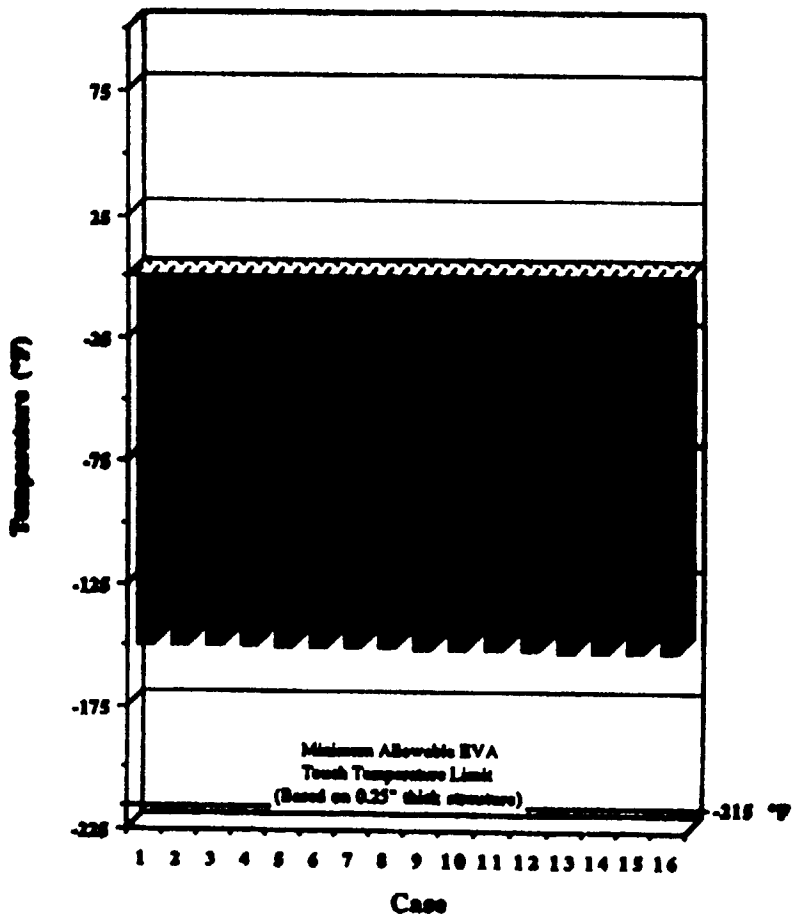
Case	Cold Case*		Hot Case*	
	Solar Absorptivity	Emissivity	Solar Absorptivity	Emissivity
1	0.15	0.25	0.25	0.15
2	0.35	0.25	0.45	0.15
3	0.55	0.25	0.65	0.15
4	0.75	0.25	0.85	0.15
5	0.15	0.45	0.25	0.35
6	0.35	0.45	0.45	0.35
7	0.55	0.45	0.65	0.35
8	0.75	0.45	0.85	0.35
9	0.15	0.65	0.25	0.55
10	0.35	0.65	0.45	0.55
11	0.55	0.65	0.65	0.55
12	0.75	0.65	0.85	0.55
13	0.15	0.85	0.25	0.75
14	0.35	0.85	0.45	0.75
15	0.55	0.85	0.65	0.75
16	0.75	0.85	0.85	0.75

*** Dispersed optical properties (0.05 dispersion for absorptivity and emissivity)**

ULC Hot Case Parametric Results



ULC Cold Case Parametric Results



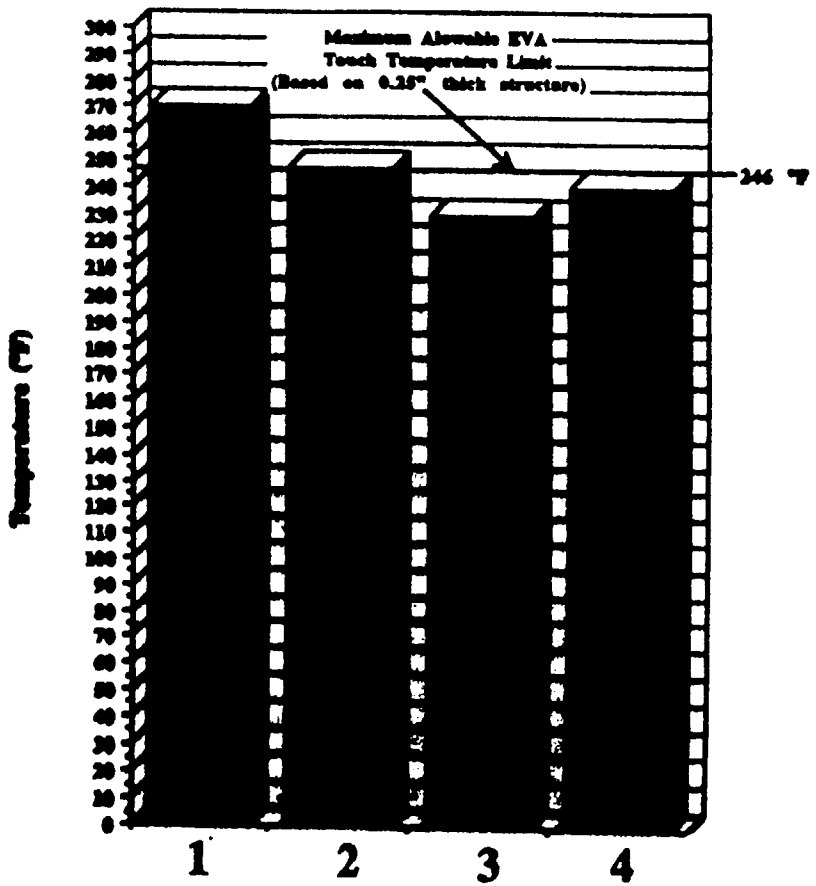
ULC Materials and Processes Analysis Cases

Case	Material	Process	Solar Absorptivity (α)	Emissivity (ε)
1	7075 Aluminum	Chromic Acid Anodize	0.54±0.03	0.75±0.02
2	7075 Aluminum	Sulfuric Acid Anodize[1]	0.44±0.06	0.82±0.04
3	7075 Aluminum	Sulfuric Acid Anodize[2]	0.32±0.05	0.75±0.05
4	2219 Aluminum	Sulfuric Acid Anodize	0.43±0.06	0.81±0.04

NOTE: A solar absorptivity degradation factor of 0.1 was applied to hot-bias the analysis cases

1. Reference PG 3 Thermal Optical Properties (DDM 057)
2. Reference PG 1 Thermal Optical Properties

ULC Materials and Process Evaluation



Discussion

- **Four materials and processes were evaluated to predict ULC temperatures.**

- **Two of the four cases resulted in acceptable ULC temperatures.**

Sulfuric Acid Anodize on 7075 Al α=0.32 + 0.05, ε=0.75 - 0.05

$T_{Max} \cong 230$ °F

Sulfuric Acid Anodize on 2219 Al α=0.43 + 0.05, ε=0.81 - 0.04

$T_{Max} \cong 240$ °F

- **One of the four cases resulted in marginal ULC temperatures.**

Sulfuric Acid Anodize on 7075 Al α=0.44 + 0.06, ε=0.82 - 0.04

$T_{Max} \cong 247$ °F

- **Since the ULC maximum predicted temperatures are close to the maximum allowable, surface optical properties must be verified.**

EXPRESS Pallet Design Review
Thermal Analysis

Shuttle Flight Analyses

- ***EXPRESS*** **Pallet/payload temperatures during shuttle transportation will be determined.**
 - **Generic flight/Mission specific**
 - **Range of Beta angles, heating parameters, and flight attitudes**

On-Orbit Analyses

- ***EXPRESS*** **Pallet/payload temperatures will be determined while Pallet is attached to ISSA.**
 - **Range of Beta angles, heating parameters, flight attitudes, and various assembly configurations**

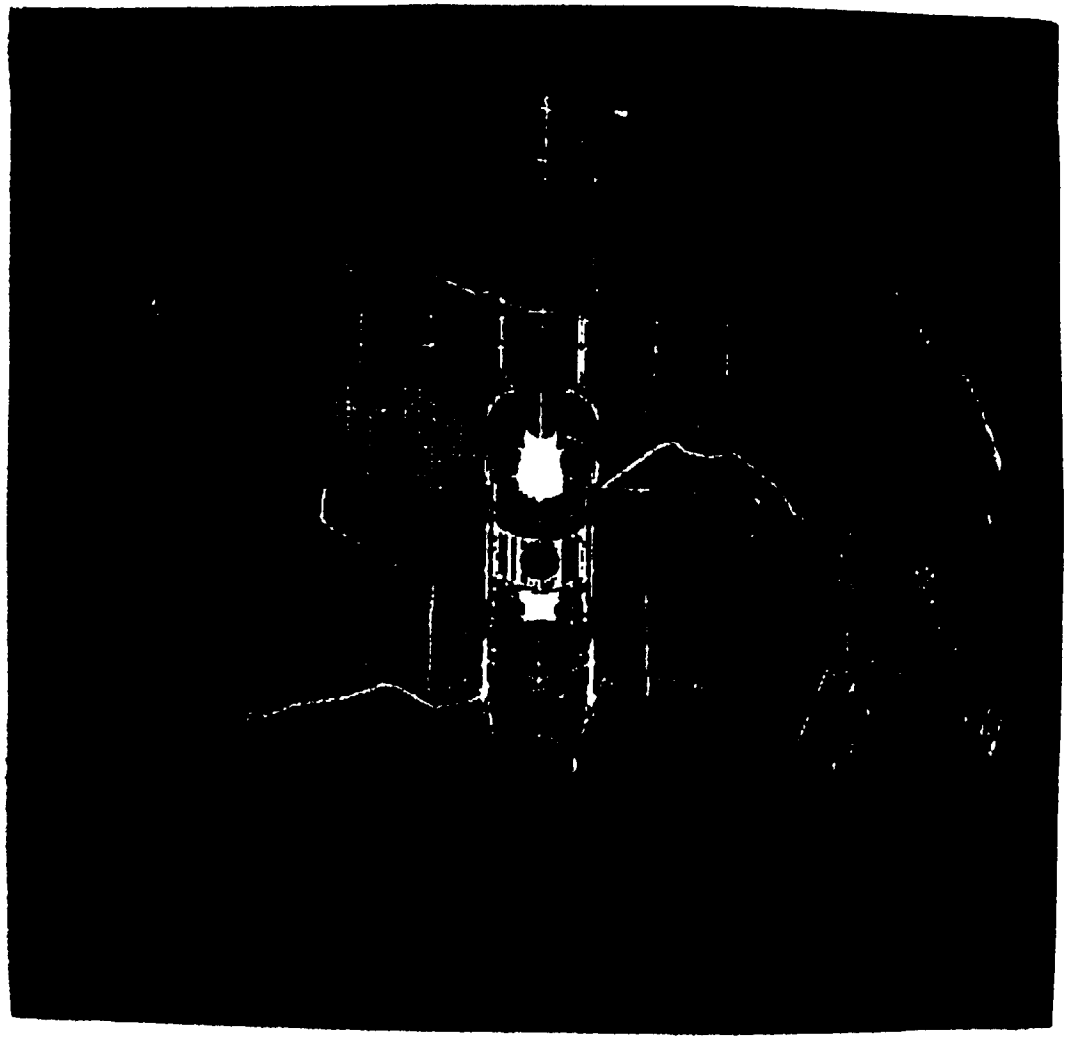
Element Level Analyses

- **Structure gradients**
- **Attach mechanisms**
- **Imposed heat applications (heater sizing)**
- **Stress induced by thermal expansions**

EXPRESS Pallet Design Review
Thermal Analysis

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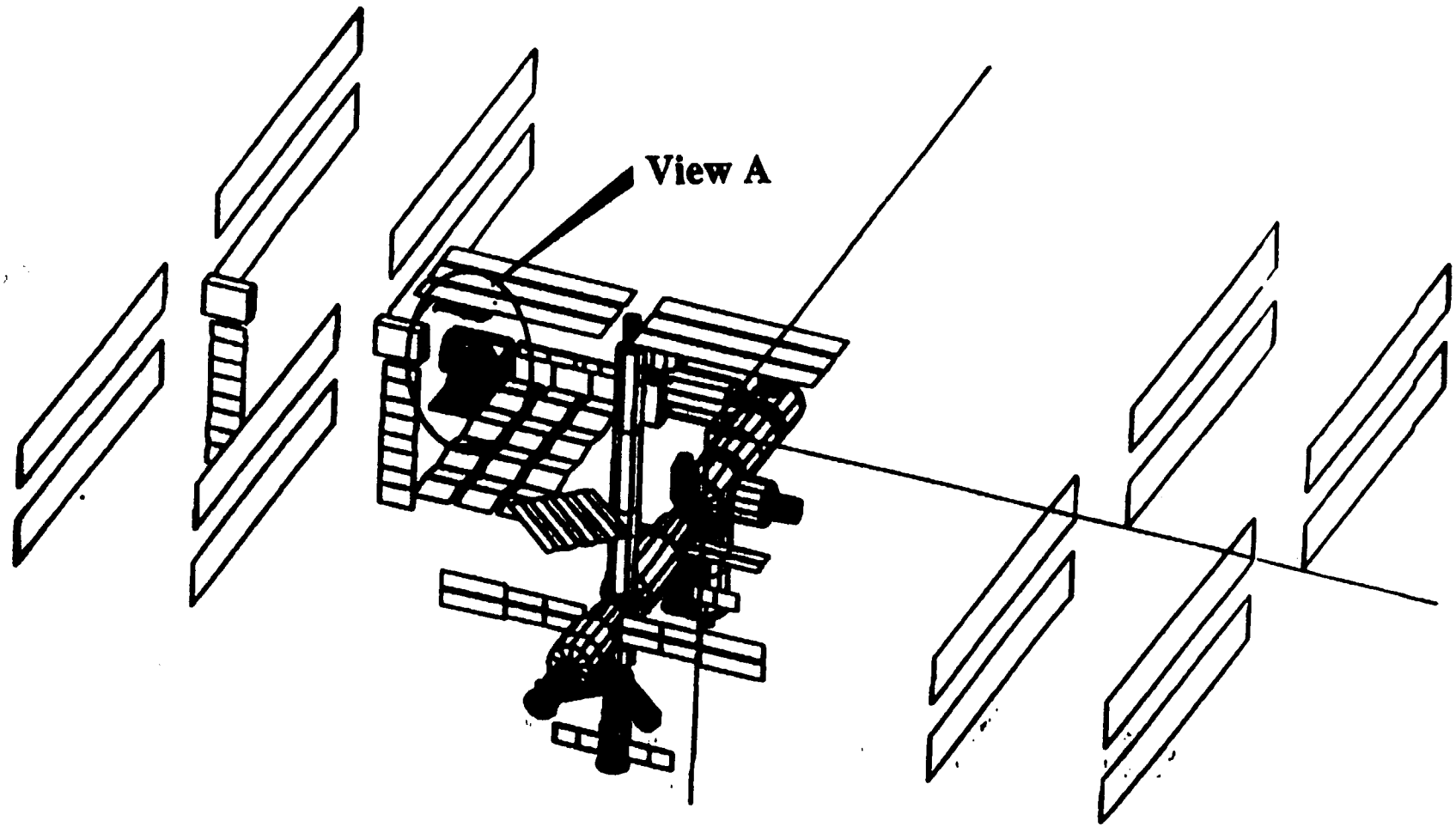
Typical Shuttle Flight Thermal Model



EXPRESS Pallet Design Review
Thermal Analysis

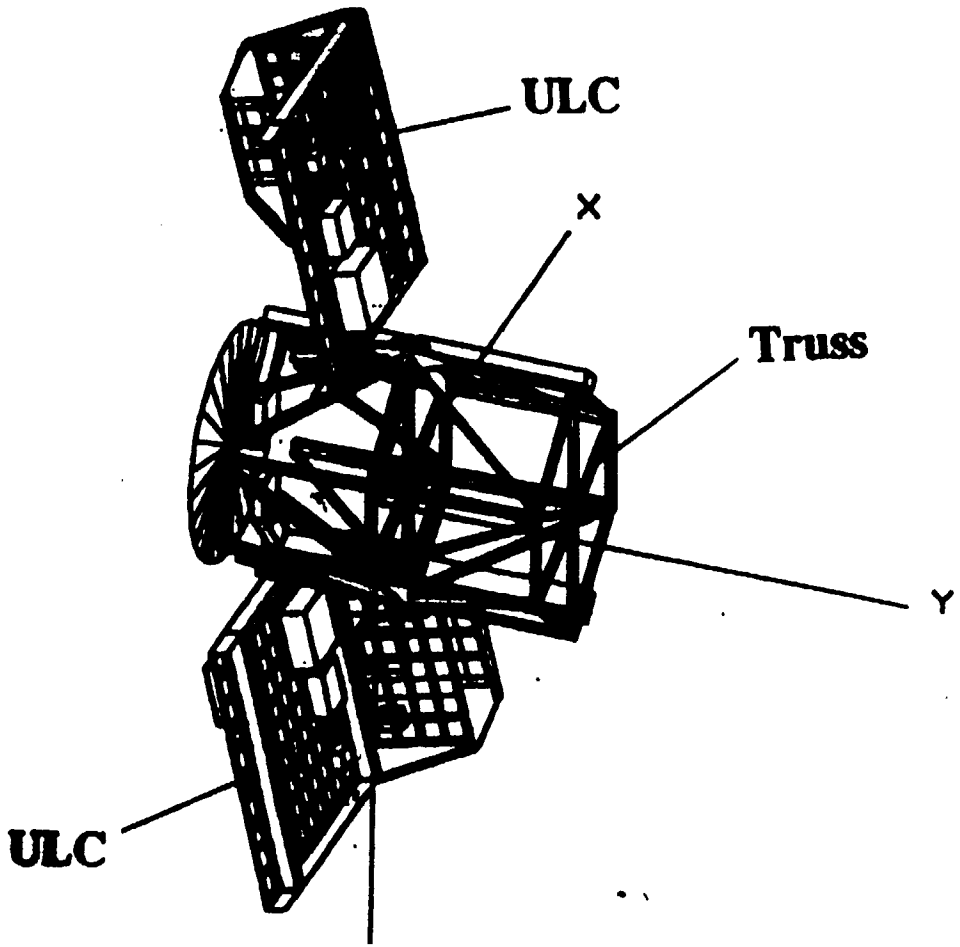
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ULC On-Orbit Thermal Model



EXPRESS Pallet Design Review
Thermal Analysis

ULC On-Orbit Thermal Model



ULC Thermal Analysis Observations

- ULC structure temperatures are driven by the on-orbit thermal environment.
- Optical properties (material and process) chosen for the ULC will determine temperatures.
 - Need PM&P support
- ULC payload temperatures are also driven by the on-orbit thermal environment (not much contribution by ULC).
 - Many payloads transported on the ULC are temperature sensitive.
- When ULC is transported in the orbiter payload bay, orbiter flight attitudes will determine ULC structure temperatures.
- Top surface to bottom surface delta-temperature was less than 200 °F.





Section XIV
Ground Demonstration vs Flight

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Jim Schaffer

Ground Demonstration Metric

- Ground Demonstration vs Flight -

EXPRESS Pallet Ground Demonstration Baseline Design Review

INTERNATIONAL SPACE STATION ALPHA

- Utilize Single Adapters
- Configure Multple Adapters
- Adapter Changeout
- Simulated ISSA Interface:
 - MS-1553
 - Command EP Controller via MS-1553 serial interface protocol
- Simulated P/L serial Interface:
 - MS-1553
 - RS-485
- Power System
 - 120 VDC to 28 VDC Conversion
 - 120 VDC Distribution
 - 28 VDC Distribution
 - MS-1553 Power System Control

- Configure EVA System Hardware (Simulated):
 - Micro-Conicals
 - "H" Fixtures
 - PFR Sockets
 - Handholds
- Robotics System Hardware (Simulated):
 - Flight Releasable Grapple Fixtures (FRGF)
 - Targets
 - Robotic Stayout Areas
- 2-Bay Configuration

Accommodation Capability

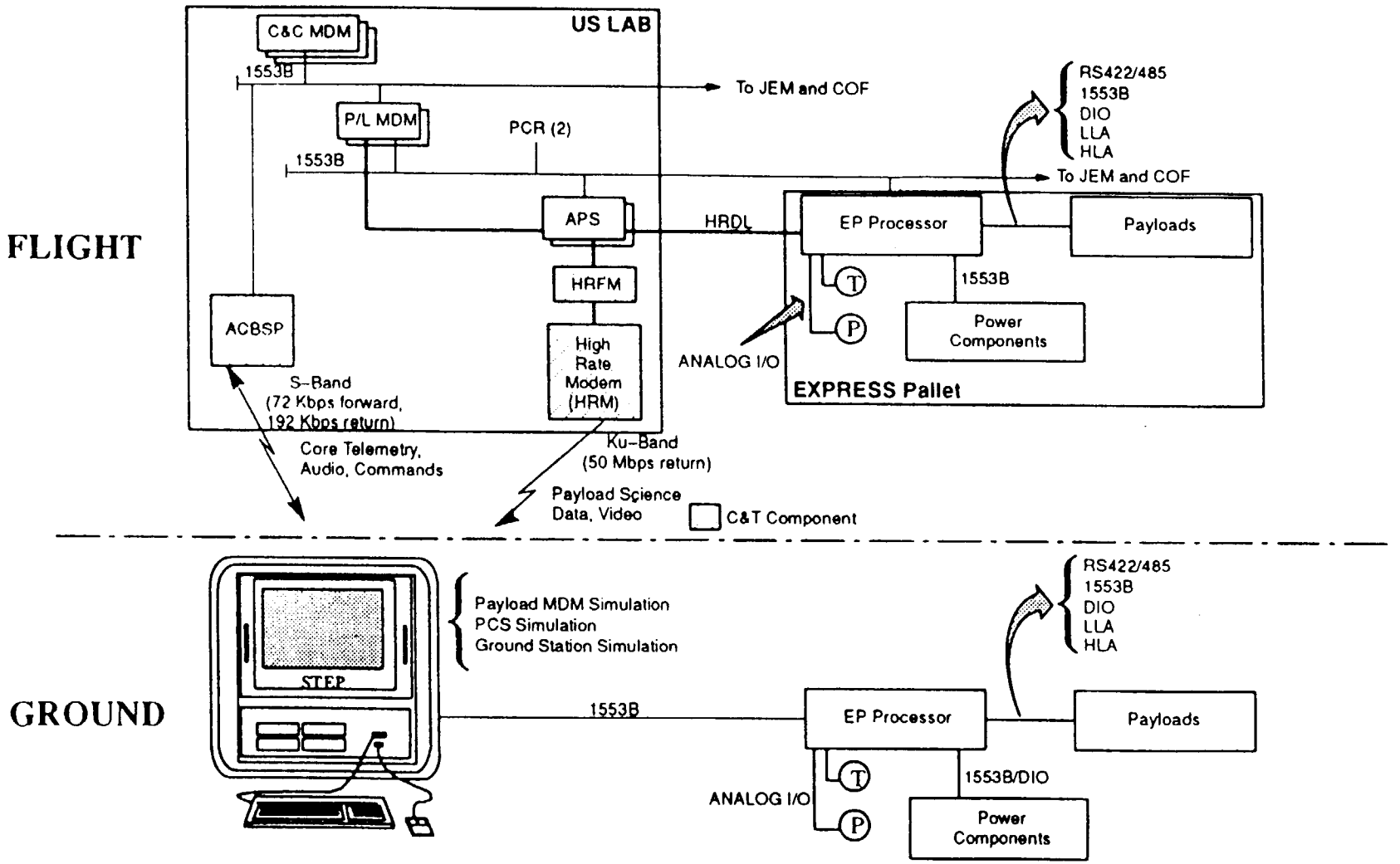
- Ground Demonstration vs Flight -

EXPRESS Pallet Ground Demonstration Baseline Design Review

	Units	Demonstration Pallet	Demonstration Adapter	Flight Pallet	Flight Adapter
Configuration		2 Bay	62.5" x 33"	6 Bay	62.5" x 33"
Payload Weight Carrying Capability [2]	lbs.	1000	500	500 [3]	3600
On-Orbit Configuration	lbs.	1000	500	500 [3]	>6000
EP Componant HW Weight	lbs.	N/A	110	1000	110
Major EVR Elements		N/A	N/A	1	6
EVR Subsystem Elements		N/A	N/A	3	0
Volume		TBD	~ 1 m3	TBD	~ 1 m3
Electrical Power	W	1 kW @ 120/28 Vdc	1 kW @ 28 Vdc	3 kW @ 120/28 Vdc	2.5 kW @ 120/28 Vdc
Functional Data Interface		1553B	1553B RS 485 Analog Discrete	1553B HRDL	1553B RS 485 Analog Discrete HRDL RAU/RIU [1]
Command & Control		Monitor, Display and command Sub. Sys. Housekeeping	Monitor, Display and Command Pallet Payloads.	Monitor, Display and command Sub. Sys. Housekeeping	Monitor, Display and Command Pallet Payloads.
Telemetry		Sim. ISS Std. Services	P/L Request	ISSA Std. Services	P/L Request via PIA
Data Storage		No	N/A	Yes	N/A
Thermal Interface		Passive	Passive	Passive	Passive

[1] Serial Interface
[2] Launch Load Configuration
[3] Single Adapter

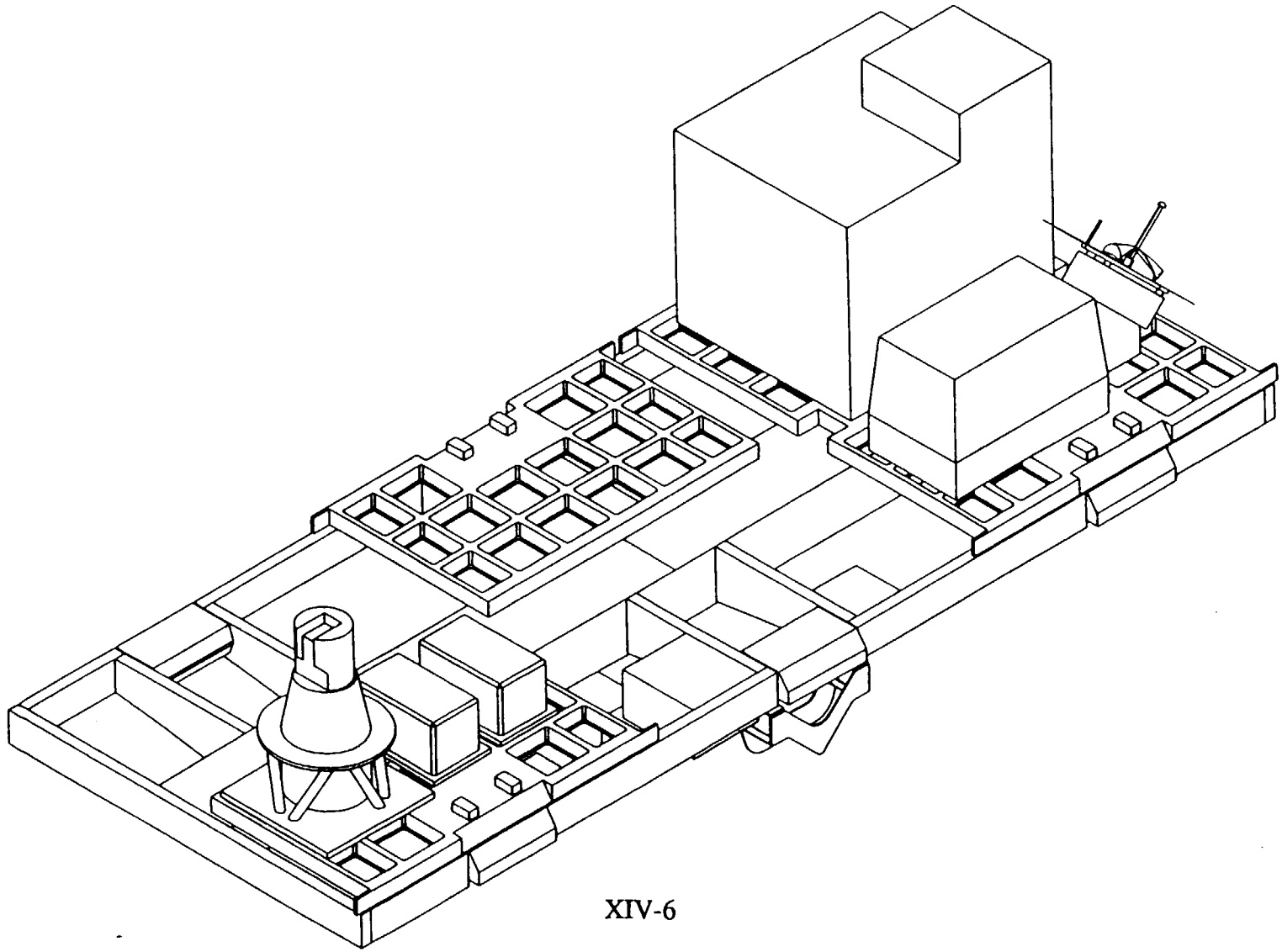
Application Software



Isometric View: Flight

- Ground Demonstration vs Flight -

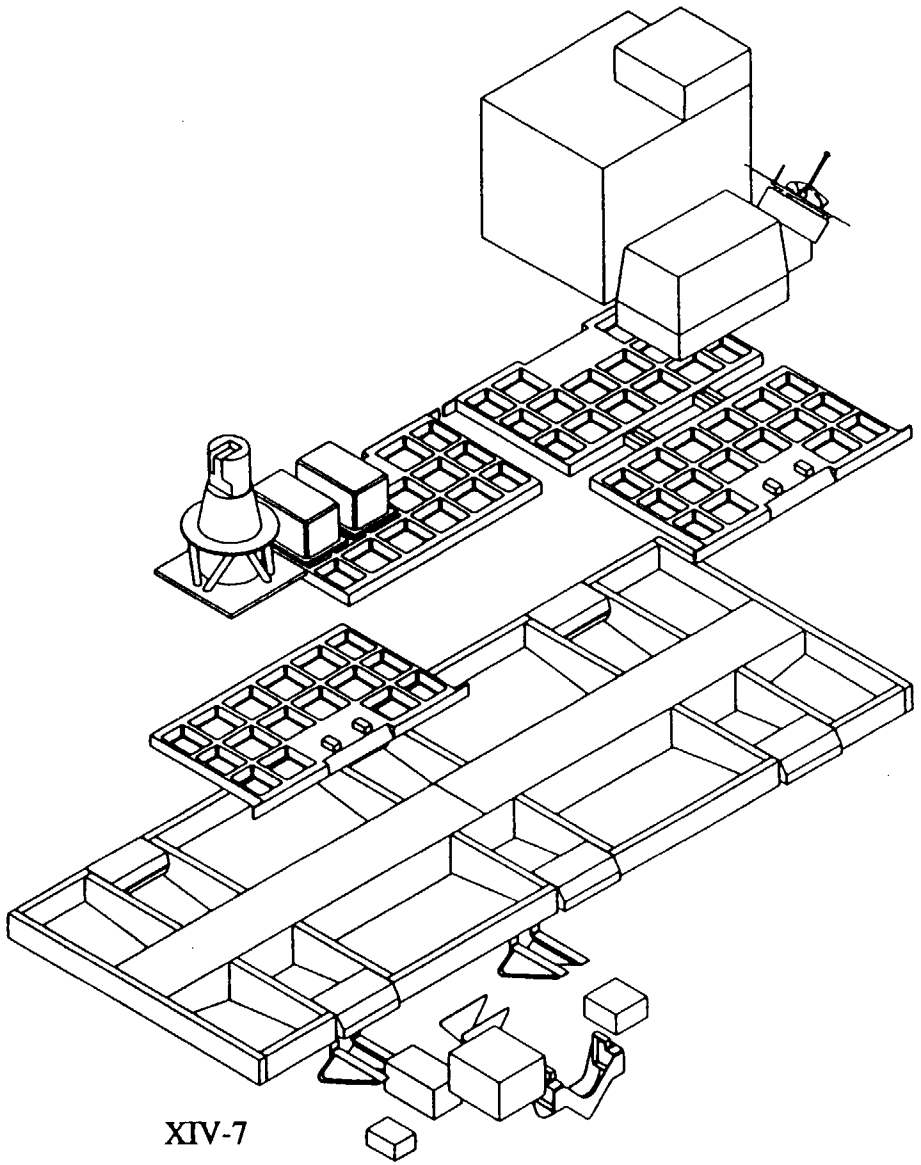
EXPRESS Pallet Ground Demonstration Baseline Design Review



Exploded Isometric View: Flight

- Ground Demonstration vs Flight -

EXPRESS Pallet Ground Demonstration Baseline Design Review







Section XV
Summary

EXPRESS Pallet
Ground Demonstration Baseline Design Review

Lowell Primm